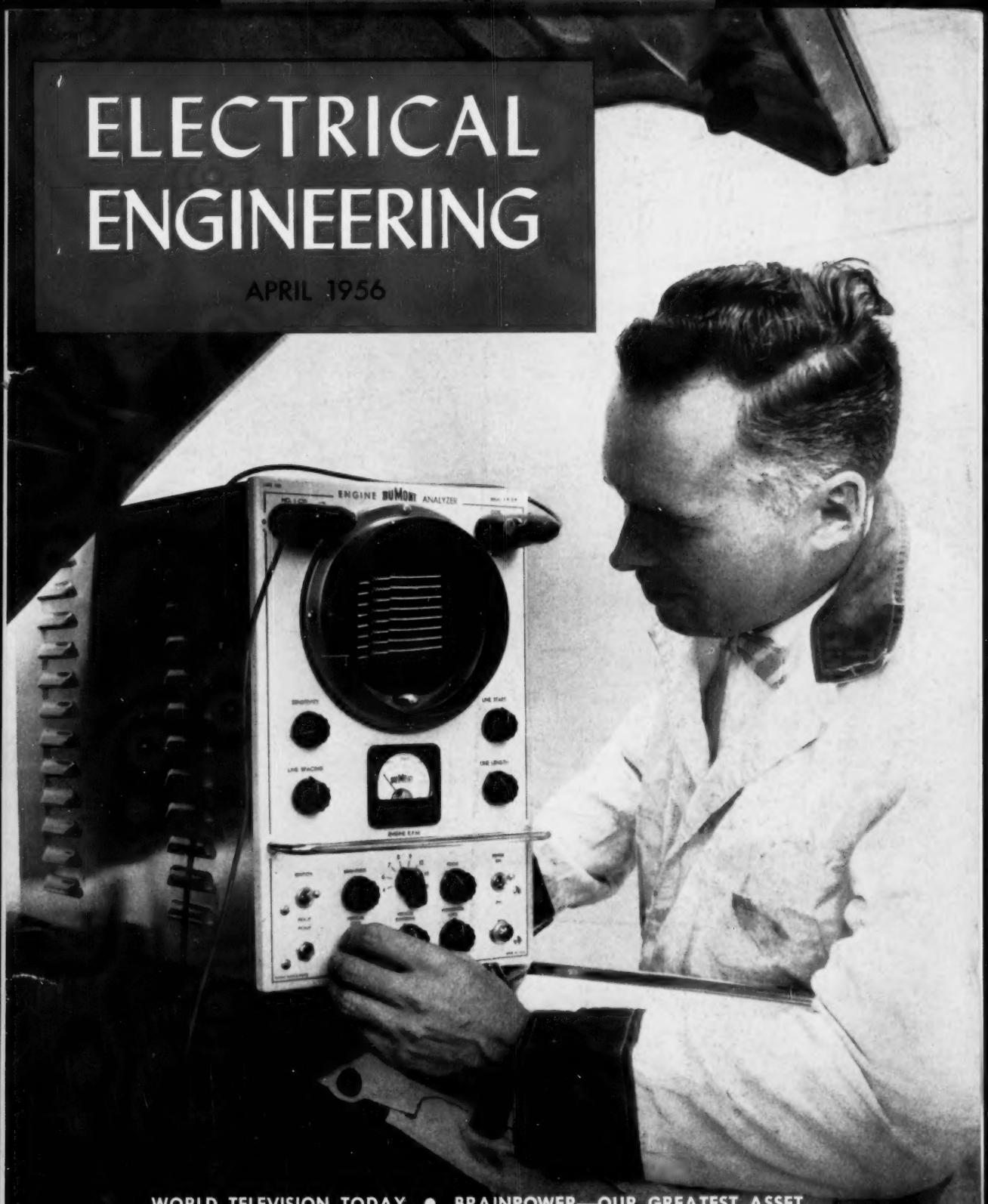
ELECTRICAL ENGINEERING

APRIL 1956



WORLD TELEVISION TODAY • BRAINPOWER—OUR GREATEST ASSET

POWER SYSTEMS VACUUM SWITCHES • NUCLEAR REACTOR SIMULATOR

GREAT LAKES DISTRICT MEETING—FORT WAYNE, INDIANA, APRIL 16–18

ALLIS-CHALMERS

NETWORK TRANSFORMERS

Space-Saving Solution To Network Problems

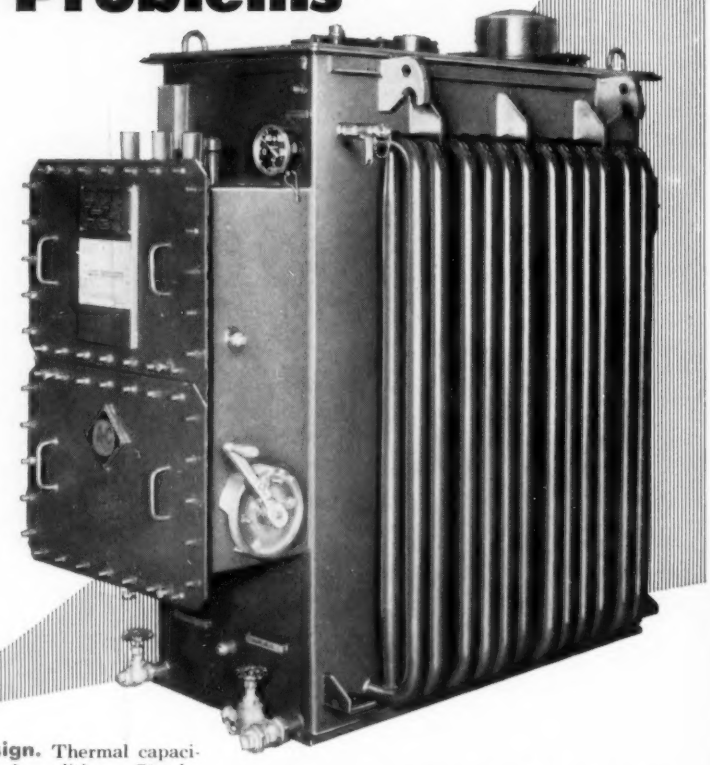
COMPACT design means savings in high-cost space when you use Allis-Chalmers network transformers. Utilities all over the country are choosing Allis-Chalmers as increasing loads put more demands on their downtown network systems. New Allis-Chalmers units are ordered repeatedly to take their place alongside the more than 1½ million kva already installed.

You get unusual flexibility in choice. To simplify application problems, Allis-Chalmers builds all three types: oil-filled, *Chlorextol* liquid-filled, and sealed dry-type.

Investigate all the advantages of compact, reliable Allis-Chalmers network transformer design. Consult your nearby A-C district office or write Allis-Chalmers, Milwaukee 1, Wisconsin.

A-4781

Chlorextol is an Allis-Chalmers trademark.



Compact, low-loss design. Thermal capacities are high for severe load conditions. Sturdy, time-proved core and coil construction withstands repeated short-circuit stresses of network operation.

Safe, dependable tap-changing mechanism. Handle inserted through two-inch opening on cover operates mechanism. Handle cannot be removed unless it is in positive tap position. Cover location of handle entrance eliminates packing gland maintenance.

Threaded valve connections to tank are solder-wiped for extra protection. Valves are located for easy access. Globe-type valves with nonrotating seats close tight, avoid wear on valve seats.

Spiral-wound gaskets have proved their superiority over other types of gaskets for sealing bushings in the tank wall in over 7 years' continual use. Alternate plies of preformed spring-like metal and nonmetallic fillers provide unusual resilience and actually adjust themselves to changes in operating conditions. Gaskets can be installed without cements or grease. They can be quickly removed if required and may be re-used.

Shot blast cleaning, three coats of baked-on paint formulated for high water resistance, and protective compound treatment of base and tubes in base area give superior surface treatment.

A-C ALLIS-CHALMERS

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ELECTRICAL ENGINEERING

APRIL 1956
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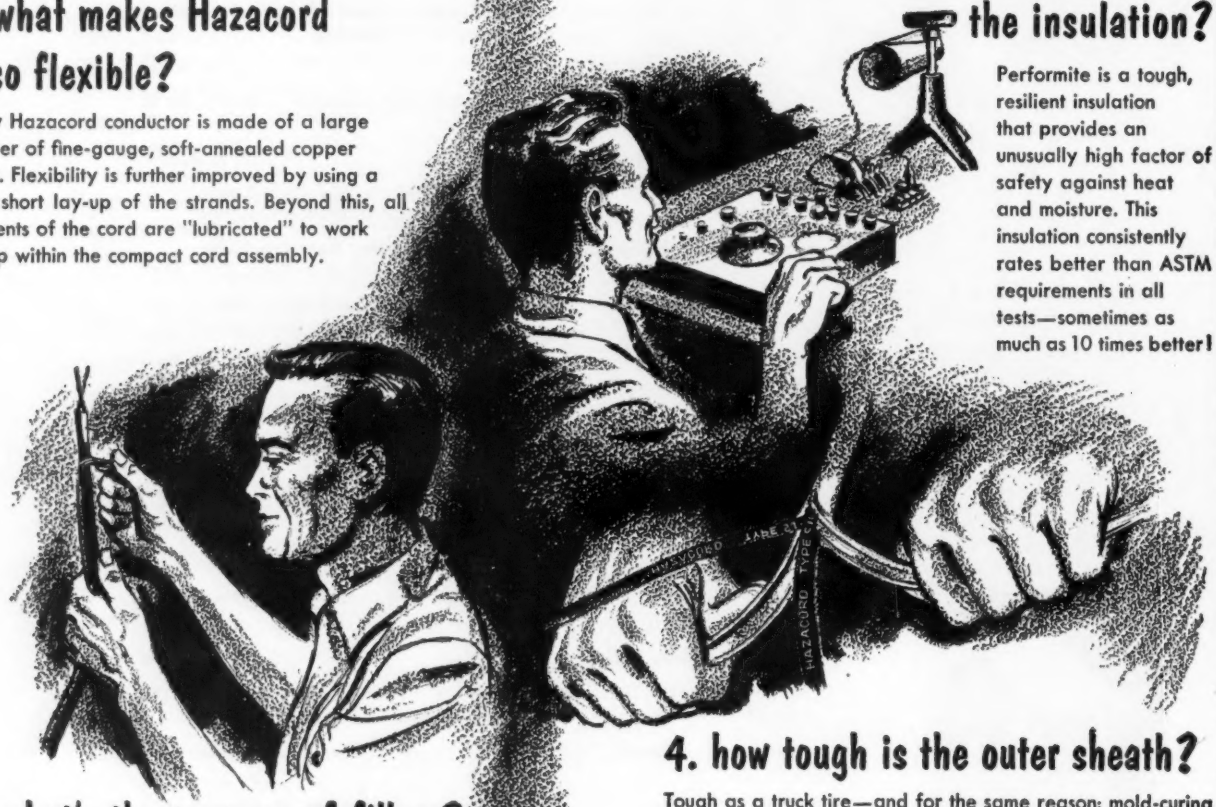
4 points about HAZACORD ...that every cord buyer should know

1. what makes Hazacord so flexible?

Every Hazacord conductor is made of a large number of fine-gauge, soft-annealed copper wires. Flexibility is further improved by using a very short lay-up of the strands. Beyond this, all elements of the cord are "lubricated" to work or slip within the compact cord assembly.

2. what's so special about the insulation?

Performite is a tough, resilient insulation that provides an unusually high factor of safety against heat and moisture. This insulation consistently rates better than ASTM requirements in all tests—sometimes as much as 10 times better!



3. what's the purpose of fillers?

They fill out the construction, protecting the insulation from damage by crushing, and give additional longitudinal strength for pulling or suspension. In Hazacord, these fillers *completely* fill in the area between conductors without lessening flexibility.

4. how tough is the outer sheath?

Tough as a truck tire—and for the same reason: mold-curing of a properly designed compound. Every foot of the specially-compounded Hazaprene ZBF Sheath is cured in a metal mold. Result: a protective sheath that's tough enough to take just about any kind of treatment in service.

3398

Complete information in Bulletin H-451. Hazard Insulated Wire Works, Division of The Okonite Company, Passaic, New Jersey.

HAZACORD mold-cured PORTABLE CABLES

PRODUCT OF OKONITE RESEARCH

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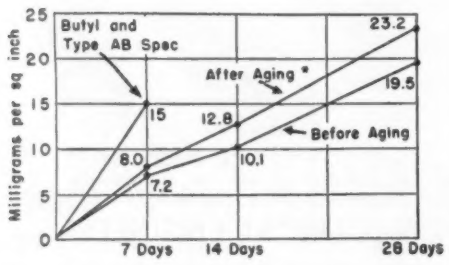
Amazing moisture resistance of Anaconda's Type AB butyl high-voltage insulation helps reduce failure due to moisture.

When you can't keep cable out of moisture

New insulation keeps moisture out of cable

Exceptional moisture resistance is provided by Anaconda Type AB butyl insulation.



RESULTS OF mechanical moisture absorption test show Type AB retains good moisture resistance even after aging.

Where rubber-type cable is installed in underground ducts or buried directly in the earth, the moisture-resistance properties of the *insulation* are vitally important.

Latest facts show *Anaconda's Type AB butyl high-voltage insulation absorbs far less moisture* than industry standards permit. For the mechanical moisture absorption test, the industry has regarded 15 milligrams increase in weight per square inch of exposed surface, after 7 days' immersion at 70C, as a criterion for satisfactory moisture resistance. Type AB easily meets that requirement – in fact, typical results show it absorbs less than 7.2 mg. in 7 days.

New Engineering Bulletin EB-27 gives you full details on performance of Type AB insulation in 15 Industry Specification tests. Ask the Man from Anaconda for your copy. Or write: Anaconda Wire & Cable Company, 25 Broadway, New York 4, N. Y.

562196

Get all the facts on Anaconda butyl. Write today –

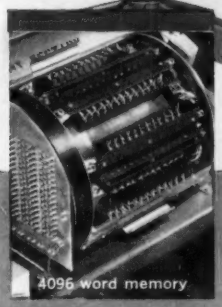
ASK THE MAN FROM ANACONDA®

–PIONEER IN BUTYL INSULATION

the new approach to large scale computations in research and development!

LGP*30

THE NEW LIBRASCOPE GENERAL PURPOSE COMPUTER



4096 word memory

SPECIFICATIONS:

Word length:
30 bits, and sign
Mode of Operation:
Serial, one address
Program Storage:
Internal
Access time:
8.5 ms av. 2 ms min.
Transfer time:
1 ms min, 17 ms max.
+ time: .26 ms
+ × time: 17 ms
Power: 1500 Watts

One word defines the "new approach" of the LGP-30...SIMPLICITY. *Operating Simplicity*...for the average engineer...made possible by the elimination of non-essential commands. Programming techniques are easily mastered. *Design simplicity*...that results in complete mobility. The LGP-30 may be operated from any 115 Volt AC outlet. *Service simplicity*...because fewer components, conservatively operated, mean less "time-out" for maintenance. And, too, the LGP-30 costs considerably less than any other general purpose computer—to buy and operate.

Write for brochure describing applications, operation and detailed specifications.

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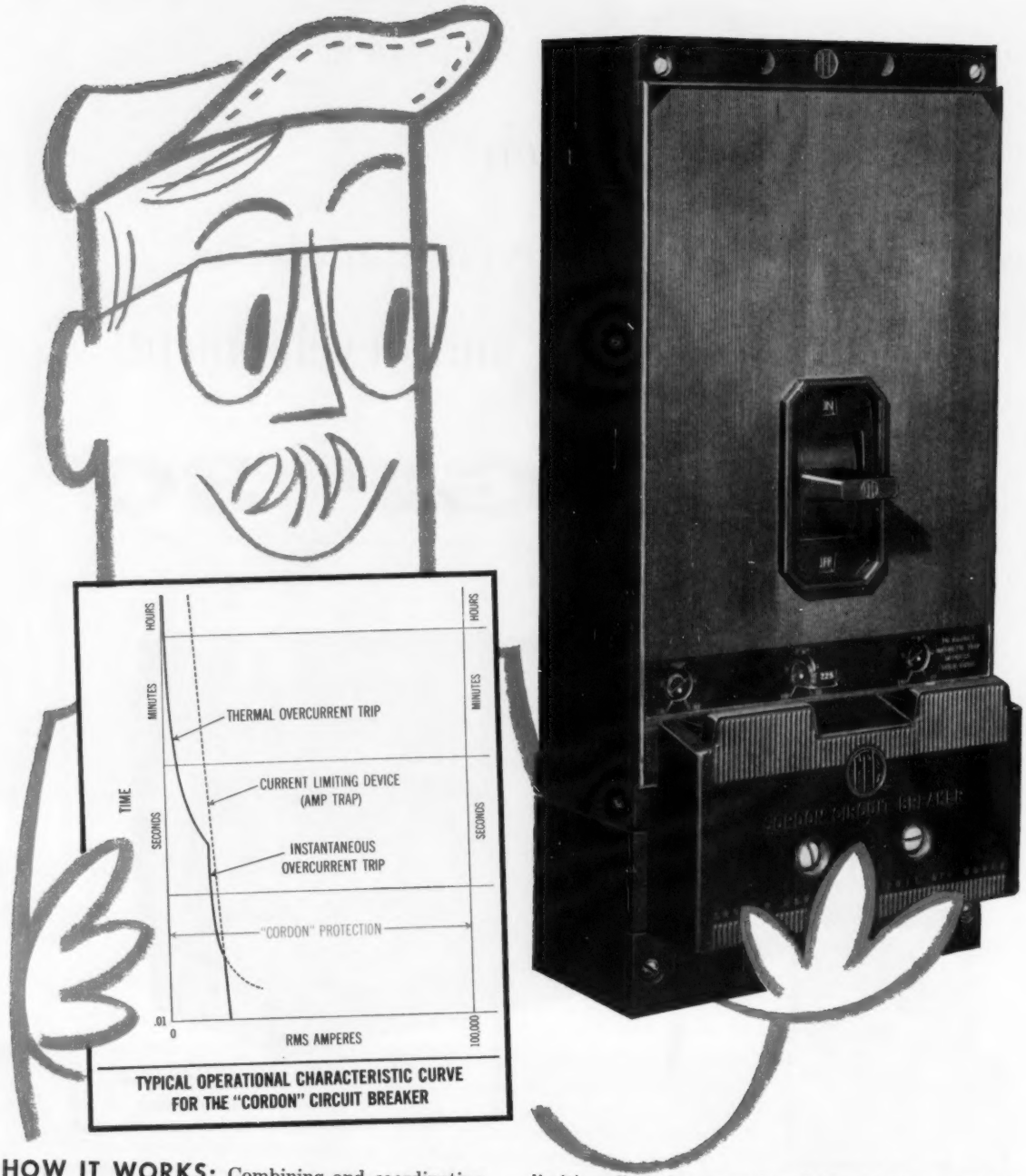
A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

LIBRASCOPE, INC. • 808 WESTERN AVE. • GLENDALE, CALIFORNIA



TYPICAL OPERATIONAL CHARACTERISTIC CURVE FOR THE "CORDON" CIRCUIT BREAKER

HOW IT WORKS: Combining and coordinating standard circuit breaker characteristics with specially designed current limiting Amp-traps, the "Cordon" circuit breaker achieves the characteristics shown above.

The thermal, magnetic trip unit provides coordinated protection against overloads and short circuits up to a predetermined value. At this point the current limiting Amp-traps assume the fault-clearing duty and extend short circuit protection to 100,000 rms amperes.

Therefore, unless the magnitude of a short circuit reaches the fusing point, the Amp-traps are unaffected, and the standard circuit breaker overload devices perform their normal function. Since the fast clearing time of the Amp-trap (less than ½ cycle) provides a current limiting effect, the magnetic and thermal stresses, which are proportional to the square of the current, are greatly reduced. Consequently, the standard molded case type circuit breaker safely withstands the heavy fault current, and the necessity of designing structures for maximum available short circuits is eliminated.

The Amp-traps are mounted in a molded housing which plugs into the load side of the breaker forming one compact unit. A design feature of the "Cordon" circuit breaker actuates a common tripper bar when any Amp-trap blows, opening all poles of the circuit breaker. Until the blown Amp-trap is replaced the circuit breaker cannot be closed. A mechanical linkage arrangement automatically opens the circuit breaker when the Amp-trap housing is removed.

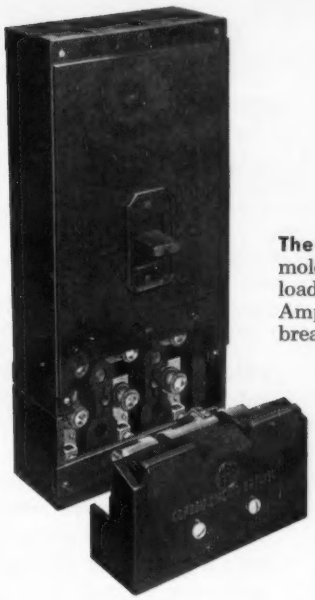
New I-T-E "CORDON" Circuit Breaker

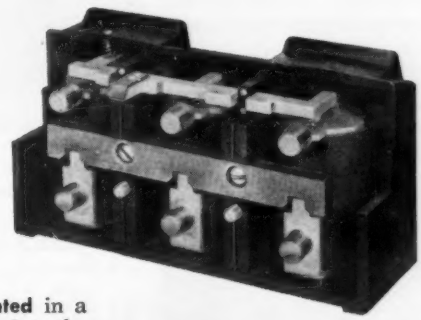
100,000 amp interrupting rating in molded case circuit breakers

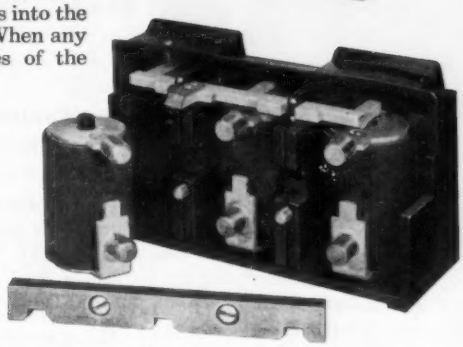
Now—one compact circuit breaker provides the practical, economical solution to meet constantly increasing interrupting requirements. The new "Cordon" circuit breaker provides all of the design and operating advantages of the famed I-T-E molded case breaker, plus interrupting ability up to 100,000 rms amperes.

The "Cordon" circuit breaker can be utilized in normal branch and feeder circuit applications in switchboards, panelboards, load centers, and individual enclosures. Plug-in mounting, rear connected studs, or front connected terminal mounting arrangements are optional.

"Cordon" circuit breakers are available with 2 or 3-pole construction in 100, 225, 400 and 600 ampere frame sizes, 250 v d-c and 600 v a-c. Write for complete details or call your nearest I-T-E office. I-T-E Circuit Breaker Company, Small Air Circuit Breaker Division, 19th & Hamilton Sts., Phila. 30, Pa







The Amp-traps are mounted in a molded housing which plugs into the load side of the breaker. When any Amp-trap blows, all poles of the breaker are opened.

Draw-out design feature of Amp-trap housing provides accessibility to simplify change of Amp-trap. Amp-trap stud design assures proper alignment and positive connection when inserted in the breaker frame.

To replace a blown Amp-trap (indicated by released plunger) you simply loosen two screws, remove the retaining bar, withdraw the blown unit, insert the new one, and replace the retaining bar.

I-T-E CIRCUIT BREAKER COMPANY

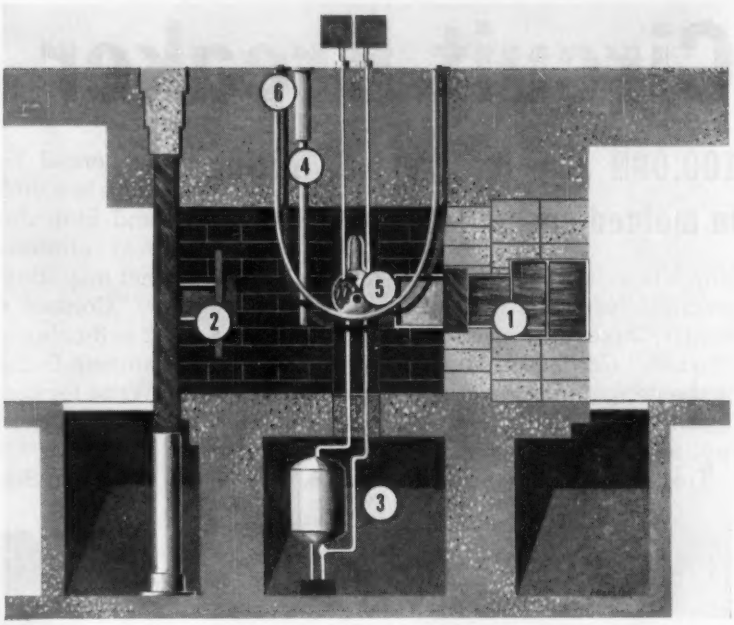
Small Air Circuit Breaker Division

NUCLEAR NEWS FROM ATOMICS INTERNATIONAL

Nuclear Reactor for Cancer and Other Medical Research

This new reactor utilizes the proven homogeneous solution design based on the SUPO unit at Los Alamos—modified and adapted to the special needs of cancer and other medical research and therapy. To be built by ATOMICS INTERNATIONAL for a prominent southern California university Medical Center, the reactor will provide a variety of radiological facilities—primarily high purity neutron and gamma beams with controlled exposure times in each. The thermal neutron flux at the central exposure tube is 1.7×10^{12} n/cm²-sec. at a power of 50 Kw.

Gas handling system assembly for nuclear research reactor. This component, developed by Atomics International, contains facilities for circulating the reactor atmosphere, recombining the radiolytic gases, condensing the water vapor and returning water to the reactor core, in a closed cycle operation. Additionally, the tank at top which contains fission product gases, provides an intense source of neutron-free gamma radiation.



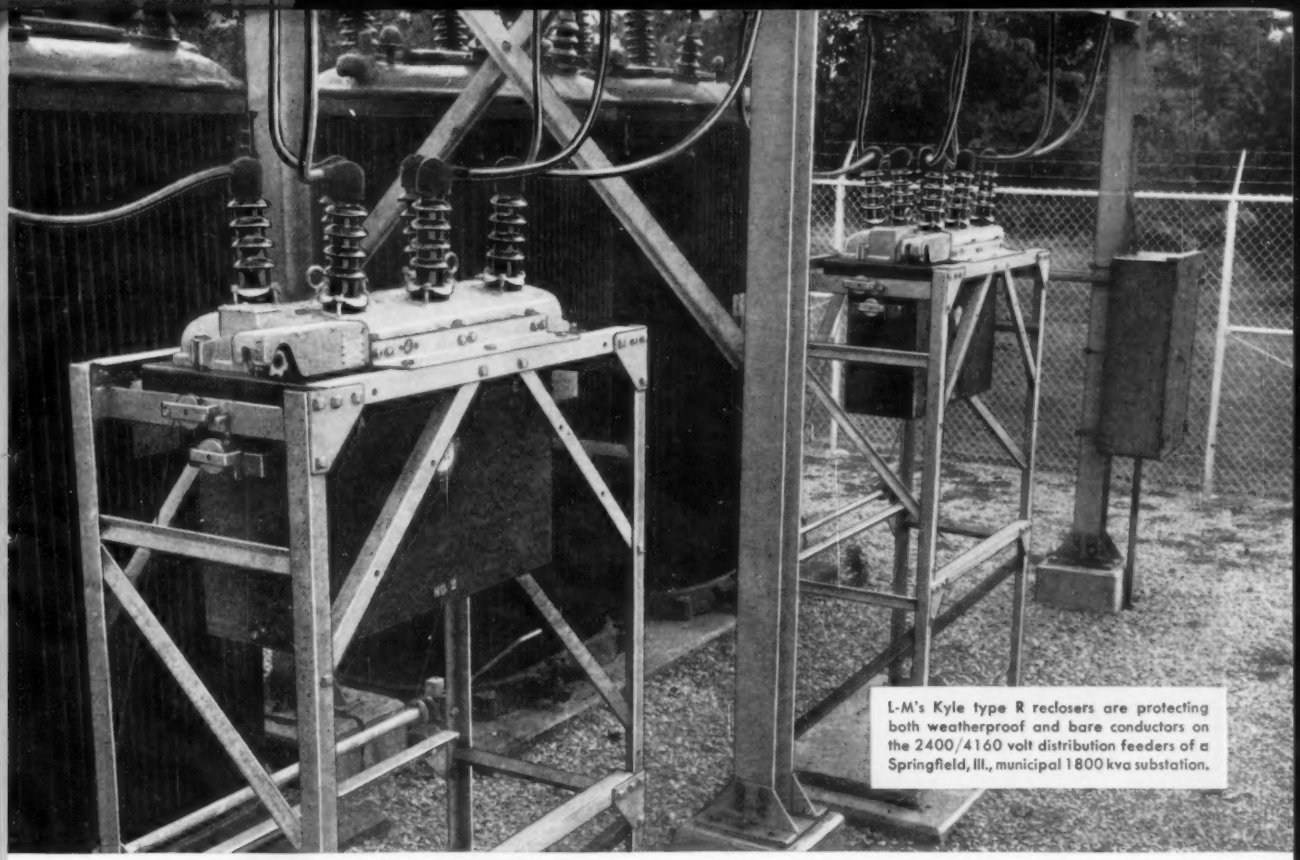
Medical Reactor Test Facilities

1. Gamma and Fast Neutron Facility—Gamma intensities of 1.3 reb/min/Kw and fast neutron intensities of 4 reb/min/Kw are available.
2. Thermal Neutron Facility—Provides neutron flux of 3.8×10^7 n/cm²-sec. per kilowatt.
3. Gamma Radiation Area—Activity of the fission gases provides a radiation source in the gas handling equipment room.
4. Multiple Specimen Irradiation Tube—One or more in the reflector. Each accommodates 16 samples.
5. Central Exposure Tube—A 1-inch internal diameter tube through the center of the core permits access to maximum neutron flux.
6. Pneumatic Tubes—Tangential to core. Also (not shown) are Beam Tubes—Radial to core, or through reflector tangential to the core.

One Configuration of the thermal neutron facility provides a neutron flux of 3.8×10^7 n/cm²-sec/Kw with a gamma ray intensity of only 0.1 reb/min./Kw (reb—roentgen equivalent biological). The fuel is Uranium enriched in the U^{235} isotope in the form of UO_2SO_4 dissolved in light water. This fuel-moderator solution, cooled by chilled recirculated water, is contained in a stainless steel core tank surrounded by a graphite reflector and dense concrete shield. Radiolytic and fission gases produced in operation are handled in a closed-cycle, water recombination and return system, which eliminates any discharge of radioactive core effluents and permits the re-utilization of materials.

Atomics International is a major reactor builder—experienced in the design, construction and operation of nuclear reactors for research and the production of power. If you are interested in any phase of our activities, ATOMICS INTERNATIONAL is staffed and equipped to help you. Please write: Applications Engineering Service, Dept. EE-N1, ATOMICS INTERNATIONAL, P.O. Box 309, Canoga Park, California. Cable address: ATOMICS.

ATOMICS INTERNATIONAL
A DIVISION OF NORTH AMERICAN AVIATION INC.
PIONEERS IN THE CREATIVE USE OF THE ATOM



L-M's Kyle type R reclosers are protecting both weatherproof and bare conductors on the 2400/4160 volt distribution feeders of a Springfield, Ill., municipal 1800 kva substation.

Improve Service Continuity . . .

High-Speed Kyle Type R Reclosers Reduce Conductor Burn-Down

by **FRANK McSTAY**
Product Manager
Kyle Products
Line Material Company

The operating speeds of conventional circuit breakers in many cases do not interrupt transient faults fast enough to prevent burn-down of weather-proof conductors or loss of mechanical strength of bare conductors. For this reason, Line Material Company engineers have designed fault-protective devices with extremely fast opening characteristics that will *minimize permanent system faults* resulting from transient or non-persistent causes.

Reduce Damage Caused By Transient Faults

L-M Kyle reclosers are completely automatic and self-contained. They provide high-speed circuit clearing (2-cycle maximum). Up to 90% of transient or non-persistent faults can be cleared by Kyle reclosers with no significant damage to the system or interruption of service continuity.

Ratings from 25 to 400 Amps.

The Kyle type R heavy-duty three-phase oil circuit recloser, shown above, is designed to replace breakers in substations with up to 100,000 kva fault capacity. They are available in normal load ratings from 25 to 400 amperes, with symmetrical RMS interrupting rating up to 6000 amperes at 4.8 kv and below and 4000 amperes up to 14.4 kv.

Almost any supplementary relaying scheme is adaptable to the type R recloser for substation application. Units are available with ground tripping, shunt tripping, shunt lockout, and auxiliary switches for remote control indication or low-voltage control switching.

Kyle Type R 3-Phase Reclosers available in normal load ratings FROM 25 TO 400 AMPERES

Ratings Amps.	Min. Trip Amps.	Inter. Ratings RMS Amperes 4.8 kv	14.4 kv
25	50	1500	1500
35	70	2100	2100
50	100	3000	3000
70	140	4200	4000
100	200	6000	4000
140	280	6000	4000
160	320	6000	4000
185	370	6000	4000
225	450	6000	4000
280	560	6000	4000
400	800	6000	4000

Get the Whole Story On L-M's Kyle Reclosers and Sectionalizers

Ask your L-M Field Engineer for information and bulletins on Kyle apparatus and complete coordination—single and three-phase—from substation to load. Or write Line Material Company, Milwaukee 1, Wisconsin. In Canada: Canadian Line Materials, Ltd., Toronto, Ontario.

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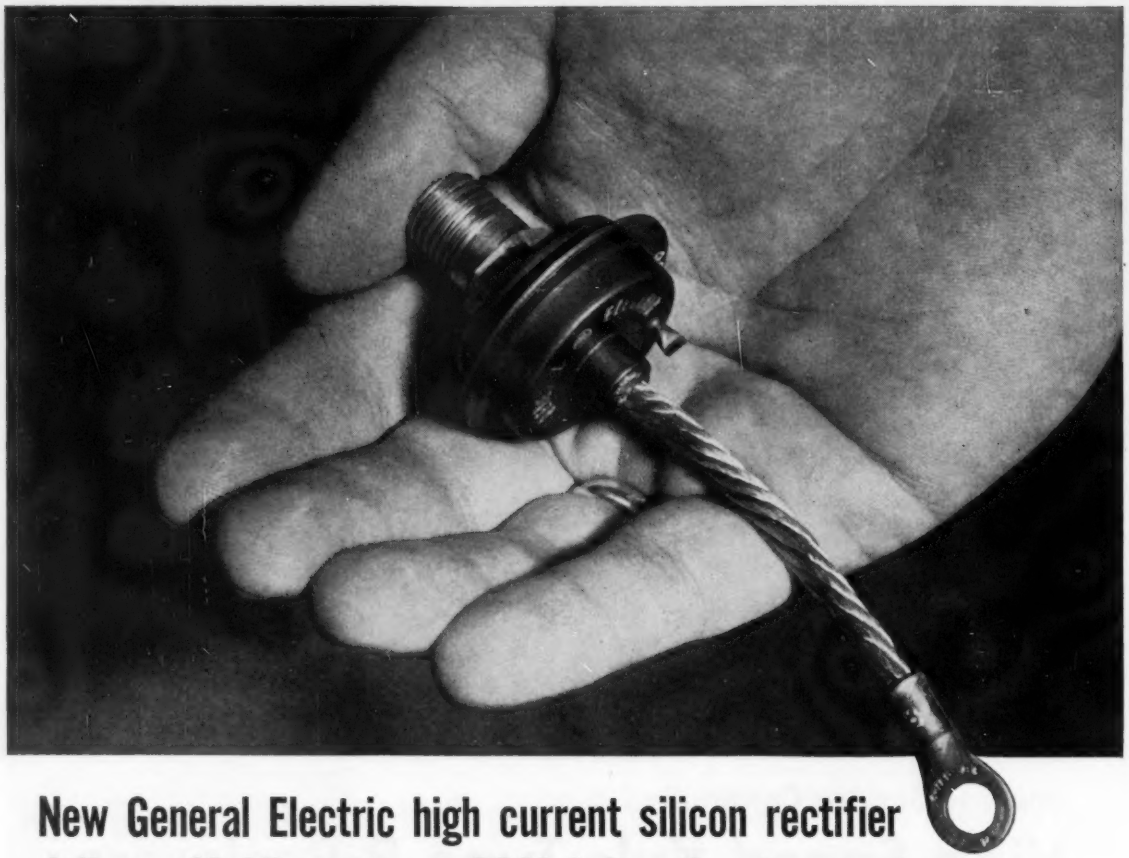
LINE MATERIAL Kyle® Reclosers

A McGRAW ELECTRIC COMPANY DIVISION



New General Electric high current silicon rectifier delivers 10 kilowatts at 200° C junction temperature

The new General Electric high current silicon rectifier delivers 10 kilowatts—from a much smaller, rugged, and more compact package. It offers improved efficiency in a wide variety of applications such as jet aircraft, locomotive propulsion motors, and electro-chemical equipment.

Exclusive General Electric Design

The compact, steel package is hermetically sealed to prevent contamination. The exclusive pipe thread stud design provides best possible thermal connection to the heat sink. As a result: The new General Electric silicon rectifier offers a more efficient and reliable method for converting AC to DC for any application. A full year warranty is your assurance of fine performance.

Many Possible Applications

The new semiconductor device will prove invaluable for rectification in the new AC distribution systems of modern jet aircraft. In the locomotive industry, the unit is used to rectify the power supply for traction motors. In the electro-chemical field—for use in electrolysis and plating equipment. Other possible applications include computer power supplies and DC central station telephone power supply equipment.

Your G-E Man Has The Details

Ask your G-E Semiconductor Specialist for the full technical characteristics, ratings, and specifications together with production and delivery information. Or, write today to: *General Electric Company, Semiconductor Products, Section X6446, Electronics Park, Syracuse, New York.*

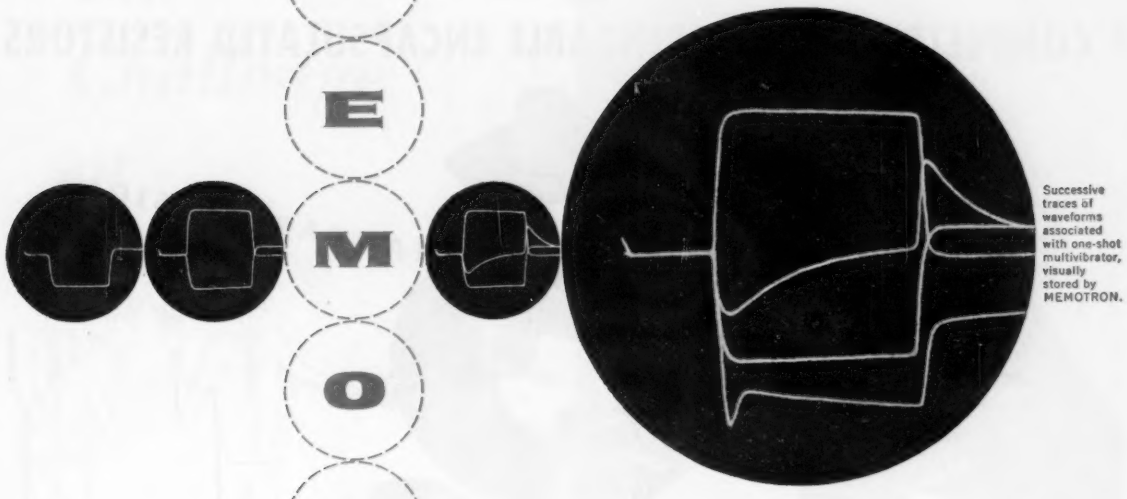
TYPICAL APPLICATION GENERAL ELECTRIC HIGH CURRENT SILICON RECTIFIER

CIRCUIT	Three Phase Bridge Rectifier, Resistive Load.
D-C OUTPUT	280 volts, 215 amperes, 60 kilowatts.
RECTIFIER LOSSES	Less than one percent (½ KW).
COOLING REQUIRED	One 6 inch square ⅛" thick copper fin for each of six rectifying units when used with 2000 fpm 35°C forced air. Free convection cooling may be utilized by increasing the fin area.
VOLUME	Total volume of rectifiers and fins—less than ⅓ of a cubic foot.

Progress Is Our Most Important Product

GENERAL ELECTRIC

HUGHES MEMOTRON



Successive traces of waveforms associated with one-shot multivibrator, visually stored by MEMOTRON.

FOR PERMANENT TRANSIENTS

Now non-recurrent phenomena ("transients") can be held and studied directly on the viewing screen of your oscilloscope. The HUGHES MEMOTRON—first in a new series of direct-display cathode ray storage tubes—captures and retains waveforms visibly until they are intentionally erased.

Since the MEMOTRON will display and retain successive writings, it is ideal for plotting curves. The tube will also store reference lines for convenient data analysis.

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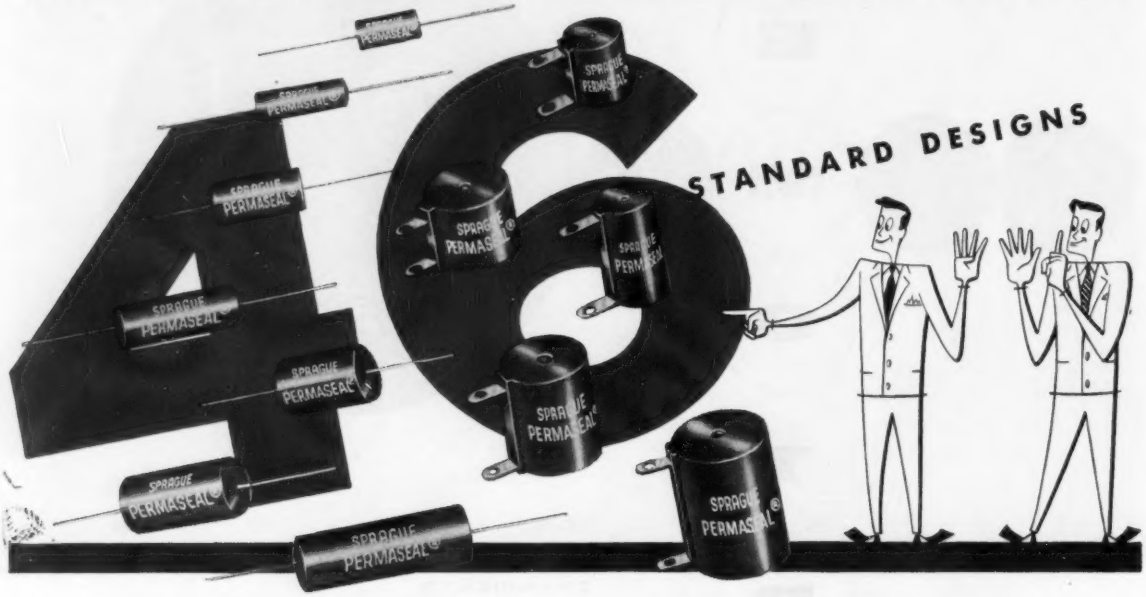

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The Challenge of America

ROGER M. BLOUGH

The present engineering shortage is discussed, with stress on industry's responsibility to utilize effectively the available supply of skilled manpower. The growing prestige of the engineering profession is emphasized.

YOUR INVITATION TO SPEAK at this Winter Meeting of the American Institute of Electrical Engineers could not have been more fortunately timed. It arrived one day last summer when a group of us in U. S. Steel were discussing ways and means of finding more good engineers and scientists.

Now I am a great believer in that old Spanish proverb—or is it a Chinese proverb—that if you are going to hunt for quail, it is quite helpful to go where the quail are. And if you can find a large covey of quail, then the hunt is so much the better.

We in U. S. Steel have been hunting more good engineers now for quite a while. I am happy to report that we have been able to bring home quite a few fine specimens who seem to like their new environment. But large coveys of engineers have been mighty scarce for the past several years. You can now understand why I accepted this invitation so readily. Need I go further? Suppose we just say I came because of that comfortable feeling I get from being near so many hundreds of good engineers.

Nevertheless, I do not mind telling you that I was somewhat dismayed, and completely overwhelmed, when I found in the Encyclopedia Britannica a description of the qualifications which professional engineers are expected to possess. I knew, of course, that you fellows had "organized habits of memory and a large capacity for information" along with the ability to "keep abreast of human progress."

But I was really stumped when I read that the professional engineer must have "intellectual and moral honesty, courage, independence of thought, fairness, good sense, sound judgment, perseverance, resourcefulness, ingenuity, orderliness, application, accuracy, and endurance." And still quoting, "An engineer should have ability to observe, deduce, apply, to correlate cause and effect, to co-operate, to organize, to analyze situations and conditions, to state problems, and to direct the efforts of others. He should know how to inform, convince, and win confidence by skillful and right use of facts. He should be alert, ready to learn, open-minded, but not credulous. He must be able to assemble facts, to investigate thoroughly, to discriminate clearly between assumption and proved knowledge. He should be a man of faith, one who perceives both difficulties and ways to surmount them."

DEPENDENCE UPON ENGINEERS

NEARLY EVERYTHING we do—and practically all the conveniences we have—depend for their creation and maintenance upon our engineers and scientists, including, on a rising crescendo of importance, our electrical engineering friends. In our work in the steel industry, for example, we advance when you advance, and our progress is slowed when your progress is halting. And I am sure that that applies to all industry.

This dependence upon you and the others in kindred

Essentially full text of an address presented at the general session of the AIEE Winter General Meeting, New York, N. Y., January 30–February 3, 1956.

Roger M. Blough is chairman of the board, United States Steel Corporation, New York, N. Y.

engineering and scientific fields is a very real and conscious thing. In more ways than we readily realize, it is upon you whom we rely not only for our progress but also for our protection.

There is more truth than fiction in the story of the devoted old lady who began her morning prayers with these words: "Give us this day our daily bread—and enough engineers and scientists to keep us alive until tomorrow."

When, therefore, in this atomic age and the present state of world affairs, we are told that our overseas antagonists are outdistancing us in the development of young engineers and scientists, it is a matter of deep concern among many thoughtful Americans.

That concern is more than a feeling of academic pride or a fear that Americans will "lose face" if others move faster and farther in this vital field of education. It is more properly described as a feeling of impelling necessity—of basic protection—of an inward alertness akin to the adrenal-linked reaction of a cat's tail when it senses danger.

PROGRESS IN EDUCATION

SPECIFICALLY, we are told that more and more technical people are being trained each year in Russia, and that in 1954 the Soviet Union's more than 200 engineering schools and universities graduated some 53,000 engineers. In 1950—a high year—schools in the United States graduated more than 50,000, but only about 20,000 in 1954, "although the latter (1954) was a low year."

We also know that the material rewards for engineers and scientists are near the top in the Soviet system. Moreover, the education a young engineer receives in Russia in mathematics and science is good—in many respects comparable to our own—however deficient that education may be on the side of liberal arts. It has also been pointed out that it is a dangerous self-delusion to suppose that Russians individually can never match our people in scientific initiative and skill. Their first-rank men are believed by many to be comparable to our own.

Now progress in education, wherever it appears on the face of the globe, must eventually be a plus factor for mankind generally, and we in America are for it. What gives us pause is the potential for harm of unbridled engineering skill and the use of scientific knowledge for aggression. We are concerned for that type of power which is unbalanced by political restraint and lack of high human standards. And that power is growing.

Whether we like the fact or not, we know the Soviet Union is the second largest steel producer in the world. It has moved forward rapidly from a production of about 20-million tons of steel ingots in 1940 to more than 49-million tons in 1955—a gain in annual production of at least 29-million tons in 15 years. I should hasten to say, however, that in the same 15 years, steel production in the United States moved from 67-million tons to 117 million, a gain of 50 million; and we believe our steel-making capacity will be increased by another 15-million tons during the next 3 years. That gain of 50 million is, of course, almost double the production gain of the Soviet Union, even though their capacity grew percentage-wise at a somewhat faster pace than ours.

We also know the Soviet Union has been successful in developing nuclear fission and the hydrogen bomb, as well as air power of a high order. All of these developments require advanced engineering and scientific skills. All are concrete evidence that the Soviet Union's long-term bet on technical education is beginning to pay off.

Certainly we must agree then that it would be foolish to underestimate the capabilities of tyranny and dictatorship for conquest and destruction. That system in ancient Sparta overwhelmed a democratic Athens.

But while recognizing this deep-seated concern, these comparisons do not imply that the United States, with its economy of private ownership and operation, is falling behind Russia, with its government-controlled and directed economy.

I am not willing to endorse any such inference. All my experience and observations lead me to believe that our competitive economy is vastly more productive and progressive than any rigidly controlled economy in producing qualified engineers and scientists, or in producing steel or anything else. That American way has faced problems before—problems fully as difficult for the earlier periods in our nation's history as those which we now face are for us. And we in America have always risen to the challenge.

Before we rush for the hurricane cellar, let us first get a perspective on just what the problem really is of this shortage of engineers and scientists. I happen to believe that this shortage, although perhaps partially due to the low birth rate of the early 1930's, is principally the result of a free and expanding economy. The shortage was not primarily created because of any threat of communism. Even if Russia suddenly became peaceful, our economy would still need many more engineers and scientists than it now has. Thus, too much emphasis on comparisons of annual graduates in the engineering field could easily obscure not only the cause of the problem and its proper solution, but the great need for technically trained individuals to further the peacetime—and I emphasize peacetime—objectives of our nation.

SHORTAGE OF SKILLED MANPOWER

I ALSO HAPPEN TO BELIEVE that instead of this being an isolated problem, this shortage of well-trained engineers and scientists is symptomatic of growing shortages of adequate manpower in other fields of endeavor in the United States. It is rapidly becoming harder to single out one area of our industrial world or one form of human endeavor where the manpower need is greatest. Looking ahead, say for 25 years, the supply of skilled manpower seems to become less and less adequate. Yet it is certainly clear that the rapidity and the character of our progress depends on well-trained, highly principled manpower.

And I also believe that our problem of securing and training the needed engineers and scientists is already partially on its way to a proper solution, a solution found within the tested American process of responsible persons doing their own thinking and acting in a competitive economy. That is our tradition and that is our great strength. We can, I

believe, easily fall into a way of unhappily describing, as a major defect of our system, what is only a momentary problem, thereby leaving a completely erroneous impression.

There is a good lesson in the story of the Captain who was astounded one night to see his nondrinking First Mate stagger back from shore leave as high as a kite. The Captain duly wrote in the log: "Tonight, the Mate was drunk."

The next morning, the Mate pleaded with his Captain to erase the entry because it was the first time he had ever taken a drink in his life, and it didn't seem right to put a black mark on his record for just one momentary slip. But the Captain was adamant.

The next night, the Mate was on watch when the Captain returned from a quite evening at home with his family. The Captain hadn't touched a drop. So the Mate wrote in the log: "Tonight, the Captain was sober."

Now, as Al Smith would say, let us look at the record—beginning with the early settlers of America. I am sure it will not surprise you to learn that there was not even one electrical engineer among the settlers at Jamestown and Plymouth. But there was among those courageous immigrants an attitude and spirit that insured the rise of a mighty civilization. There was a willingness to accept the responsibilities of freedom—which is the challenge of America.

More than 100 years later, Benjamin Franklin, who is probably entitled to be called America's first electrical engineer, began his "kite and key" experiments. Mr. Franklin, whose 250th anniversary is being celebrated this month, is the gentleman who sagely observed that in any difference of opinion between husbands and wives, the "wives are in the right." I am sure everyone here today will accept that as an accurate description of nature's phenomena on at least an equal footing with Boyle's law.

Throughout his life, Benjamin Franklin met the challenge of personal responsibility to himself and his fellow countrymen, the challenge of the voluntary response to difficult situations that tried men's souls—the challenge of America.

More than a hundred years after those early experiments with lightning, Mr. Franklin's electricity was encased by Thomas Edison in a bulb to light our homes. The "Wizard of Menlo Park" also met the challenge of his day in the traditional American way, as did Steinmetz, De Forest, and other similar giants of the early development of our electrical industry.

NO PROGRESS WITHOUT CHALLENGE

Those scientists understood that there can be no progress without challenge. They were men of vision who knew that there are no limits to man's material and spiritual development as long as he is free to dream and to draft his own individual blueprint and to try to build according to that personal blueprint.

In the light of our history and of our tenets, what then do we do about our problem of engineering and scientific shortages? Do we run to Washington to cry about it there and ask the Government to solve our problems for us? Do we ask some Government agency to tell us how many scientists and engineers we shall need next year and every year thereafter? And do we then compel—in the Russian way—a certain percentage of our youth to study engineering in our high schools and colleges? Fortunately, we do not. Nor would it help us greatly if we did, I think.

It may interest you to recall, for example, that in 1949 the Department of Labor in its "Employment Outlook for Engineers" gazed into its cloudy crystal ball and came up with this depressing glimpse of the future:

"In the next few years," said this Department of Labor report, "the number of graduates will greatly exceed the demand for graduate engineers . . . Schools could admit even fewer students and still provide an adequate supply of engineering personnel."

To what extent this discouraging advice may have contributed to our present shortage of engineers and scientists, no one can say, of course, but clearly Washington is not the answer to our problems. And certainly we cannot—under any circumstances, and regardless of what any other nation may do—attempt to draft immature minds into unwanted careers. This would be the antithesis of freedom's way. It would also be the surest way to dull the sharp edge of youthful competence. It would mean substituting regimentation for consecrated careers. That course is not for us.

SUPPLY AND DEMAND

Our way is different. It consists of substituting incentive for compulsion and it is the proven, tested way. For it so happens that freedom's way works—and is working right now to produce more engineers.

Our economy needs and wants more engineers. As a result, the price of engineers is steadily rising. In our free society, that is the one infallible test of what is most wanted and in what amounts. It is the irrevocable law of supply and demand.

We cannot compare men to corn, for men are people and corn is a commodity. But it is, nevertheless, true in an economic sense that the demand for corn has been satisfied and its price is down, while the demand for engineers is not being satisfied and the price people are willing to pay for engineers and scientific services is going up.

Thus, although corn prices are artificially supported by the Government, engineers are drawing premium pay from people who are spending their own money for what they want most. Our young people in schools and colleges need only to turn to the Want Ads to observe the workings of supply and demand in this price system of ours. There were 34 columns of opportunities in one metropolitan newspaper alone on a single day recently. The students are beginning to see this system working and to act accordingly. Thus, greater economic recognition is one way in which we are freely solving our shortage problem.

ANOTHER SOLUTION

There is another way of relieving this shortage. U. S. Steel, along with other industries, is now trying to develop a program that might be called, "The Care, Feeding, and Propagation of Engineers."

With its large expansion and facility programs, and its fundamental and applied research programs, U. S. Steel

finds that it is steadily needing more scientists and engineers at a time when the supply is limited.

So, along with many others, we are increasing the use of electronic machines and equipment to perform some of the routine work of engineers. There is, for example, much laborious computation involved in engineering a large project, such as a bridge. One complex computer now in operation is capable of saving as much as 10,000 engineering hours on one project. So far as I know, not one of our engineers has endorsed the hoary and fallacious idea that these machines may soon cause mass unemployment among engineers—or, for that matter, among any other group. It takes engineers to create those machines, and it will take many more engineers than we have to create and build the successors to those machines.

We, likewise, have our own program of advanced study conducted by U. S. Steel men for U. S. Steel employees, utilizing text books written by U. S. Steel men who are experts in their respective fields.

Many of our employees also are being trained on the job to become technicians and assistants to engineers. We also are encouraging and aiding these technicians to become engineers themselves by attending evening classes offered by local colleges and universities. Many of them are doing so. Thus, both the engineers gain and the non-engineers gain. The entire work force moves forward a notch or two, and that is another way to take care of an ever-increasingly mechanized America.

PRESTIGE

THERE IS still another way by which our younger minds find an incentive to science and engineering. I refer to the honor and prestige you scientists and engineers now enjoy. Your profession is rapidly becoming glamorous. You are now decreed to be fit subjects for romantic novels and movies.

Now you can brush off the effect of this on younger minds if you wish, but in the pre-teen and early teen-age set this increasing respect may almost be called hero worship. I am pleased to report that the kids now think you engineers are almost as worth while as a cowboy or an Indian—not quite, you understand—but almost.

"Junior" is beginning to realize that he will never be able to "blast off" into outer space and circle the earth without your help and the help of other scientists and engineers like you. Because he wants to use that "space helmet" which he got for Christmas, he will be in a mood to listen.

So, in a manner of speaking, here is a heaven-sent opportunity from outer space for him to learn that it is only through mathematics, physics, chemistry, and those other courses in science that he can answer the call which comes to him from out of the blue yonder.

THE NEED FOR INGENUITY

IN ALL SERIOUSNESS, if our young people think those subjects will give them what they want, they will flock to them regardless of how tough by reputation the courses are. Those youngsters are more than capable of handling any course you can give them in high school. Maybe the main trouble is that you and I are not doing an ingenious enough job explaining the situation to them.

In speaking of ingenuity, I am not advocating, of course, the kind I heard about the other day. It seems that a young man—his ingenuity suggests he was a recently graduated electrical engineer—was filling out an application blank for a job. He came to this question: "If your father is not living, of what did he die?" Since the young man's father had been publicly hanged as a criminal, the job-seeker was understandably perturbed. After thinking about that question for a while, the young man came up with this answer: "My father was attending a public function and the platform gave way."

As I said, I am not advocating all kinds of ingenuity, but I am advocating that we work at the problem in a constructive way, each in his own field. If we do that, I am satisfied that the answer to this shortage and to all of our other manpower shortages will find their solution.

Our engineering schools are making much headway toward solving it. Even earlier in their lives, at the high school stage, our future engineers are being made aware—through speakers, films, literature, and guidance counseling—of the inducements in the engineering field; of the leadership positions in their respective organizations into which many graduates of engineering schools are moving. For example, I am told that the graduates of one large Eastern technical college now occupy positions of president or chairman of the board in over 1,500 firms. I know that in our own company a number of the top executive jobs, including the presidency, are occupied by individuals with engineering training.

The American Institute of Electrical Engineers, of course, is also giving this shortage thoughtful and serious attention. Committees are being formed, money is being raised and plans are being drawn, not only by your Association, but by many others. And that work will go on in many ways on many fronts with ever greater effort and effectiveness.

RECOGNIZING THE PROBLEM

WE DO NOT do ourselves a good turn by becoming panicky at the idea of the mere numbers of engineers that are being produced in other countries, or by consciously engaging in a technological numbers race. We do ourselves a good turn when we recognize our problem for what it is. It is not the problem of producing more engineers than Russia does. It is the problem of producing as many as we need, not only for our national protection, but above all for our national growth. For in balanced growth, in knowledge and human understanding lies our real—and I believe our only—lasting national protection.

We likewise do our nation a good turn when we move forward toward solving our shortage problems in a hundred individual ways; when we think of quality, competence, and the growth of well-rounded individuals; and when we lift by training, upgrading, and providing better opportunities, the whole pattern of standards for all of us in the work force. Then and only then will we be serving our common necessities—and then and only then will we be meeting the challenge of America.

Television in the World Today

C. J. HIRSCH

The various television standards in use throughout the world and comparisons of their performance are discussed. In addition, the author points out some of the difficulties arising from this multiplicity of standards.

THERE ARE, THROUGHOUT THE WORLD, a number of technical standards currently being used for television transmission. Eight different sets of standards are in use, requiring channel bandwidths of 5, 6, 7, 8, and 14 megacycles. Within Europe alone six of these eight standards are currently in practice.

No attempt is made here to discuss in detail the reasons for the existence of the multitude of standards. The several systems are described, differences are pointed out, and some comparisons of performance are made, along with some notes on the difficulties which can arise from the use of many systems.

DESCRIPTION OF STANDARDS

TABLE I LISTS the characteristics of the several standards in use at the present time and Table II lists the countries using these standards. The names given to the systems in Table I are those by which the systems are generally known. These, for the most part, are indicative of the country of origin except for system IV. This is usually known as the Gerber system and takes its name from the chairman of an international committee which recommended the system.

The relative location of sound and picture carriers within the various width channels is illustrated in Fig. 1.

CHARACTERISTICS COMMON TO ALL STANDARDS

ALTHOUGH THERE ARE MANY DIFFERENCES among systems, certain features are common to all. For example, all standards now in use

1. Scan left to right and top to bottom of the picture.
2. Interlace 2-to-1.
3. Use an aspect ratio of 4-to-3.
4. Use amplitude modulation for the picture carrier.
5. Use vestigial sideband transmission.
6. Make the black level independent of the picture content (transmit the d-c component).
7. Are capable of operating while not synchronized to the electric power systems.

CHARACTERISTICS WHEREIN THE STANDARDS DIFFER

ALL THE SYSTEMS LISTED in Table I operate with 50 fields interlaced 2-to-1 to give 25 pictures per second except the 525-line (United States) system which operates with 60 fields and 30 pictures per second. This difference is primarily due to the use of 50-cycle electric power in Europe and 60-cycle power in the United States.

The British 405-line system (system I) is the oldest in operation. It makes no use of equalizing pulses. Positive modulation is used with blanking at 30 per cent and sync at 0 to 3 per cent of peak white amplitude. The channels are 5-mc wide with a picture-to-sound carrier spacing of 3.5 mc. Amplitude-modulated sound is used.

In the United States 525-line system (system II), negative modulation is employed. Blanking occurs at 75 per cent and peak white at 10 to 15 per cent of peak carrier output. The channels are 6-mc wide with carrier spacing of 4.5 mc. Sound is transmitted by frequency modulation.

System III has been used to some extent in Latin American countries. Its channel width, carrier spacing, sound and picture modulation, and synchronizing wave form are as used in system II but with 625 lines per picture and 25 pictures per second instead of 525 and 30, respectively. This represents only a minor change in horizontal scanning frequency since $525 \times 30 = 15{,}750$ and $625 \times 25 = 15{,}625$ lines per second.

The Gerber Standard (system IV) is similar in many respects to the United States system. The channel width and the carrier spacing have been increased to 7 mc and 5.5 mc, respectively. Negative modulation and FM sound are used. Five equalizing pulses instead of six precede and follow the vertical sync interval which is 2.5 lines in duration instead of three.

System V used by the U.S.S.R. and satellite countries differs from system IV only in channel width and carrier spacing which are 8 and 6.5 mc instead of 7 and 5.5, respectively.

The French system (system VI) differs in more respects. Channels are 14-mc wide with a carrier spacing of 11.15 mc. Positive modulation is used for the picture information and amplitude modulation for the sound. The number of lines per picture is 819 with 25 pictures per second. No equalizing pulses are used; the vertical sync consists of a single 20 microsecond pulse within a 41-line blanking period.

The Belgian 625-line system (system VII) uses a 7-mc channel with 5.5-mc carrier spacing. Its synchronizing wave form is similar to that of the Gerber standard but positive modulation is used. Sound modulation is AM.

The Belgian 819-line system (system VIII) also uses a 7-mc channel with 5.5-mc carrier spacing. Here also positive modulation of the picture carrier is employed along with AM sound. The synchronizing wave form differs

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Table I. Characteristics of Television Systems

System:	I	II	III	IV	V	VI	VII	VIII
Name of System:	British	United States		Gerber	U.S.S.R.	French	Belgian 625	Belgian 819
Number of Lines	405	525	625	625	625	819	625	819
Video Bandwidth, mc	3	4	4	5	6	10.4	5	5
Channel Width, mc	5	6	6	7	8	14	7	7
Sound Carrier Relative to Picture Carrier, mc	−3.5	+4.5	+4.5	+5.5	+6.5	±11.15	+5.5	+5.5
Line Frequency, cps	10,125	15,750	15,625	15,625	15,625	20,475	15,625	20,475
Field Frequency, cps	50	60	50	50	50	50	50	50
Picture Frequency, cps	25	30	25	25	25	25	25	25
Picture Modulation	AM	AM	AM	AM	AM	AM	AM	AM
Sense of Picture Modulation	+	−	−	−	−	+	+	+
Sound Modulation	AM	FM ±25 kc	FM ±25 kc	FM ±50 kc	FM ±50 kc	AM	AM	AM

Table II. Countries Using or Planning To Use the Television Systems of Table I

I	II	III	IV	V	VI	VII	VIII
Great Britain[1]	U.S.A.	Argentina	Norway	U.S.S.R.	France[2]	Belgium	Belgium
Ireland	Canada	Brazil[3]	Sweden	Poland	N. Africa		Luxembourg
New Zealand	Mexico	Venezuela	Denmark	Czechoslovakia	Saar		
	Cuba		Netherlands	E. Germany	Monaco		
	Dominican Republic		Australia	Hungary			
	Guatemala		Austria				
	Uruguay		W. Germany				
	Colombia		Italy				
	Brazil		Spain				
	Philippines		Switzerland				
	Japan		Turkey				
	Thailand		Portugal				
	El Salvador						

1. The London and North Ireland transmitters use a 7-mc channel for double-sideband transmission.
2. Paris has one transmitter operating with 441 lines, AM sound, and 7.6-mc channel. It is planned to discontinue this channel.
3. One station in Rio de Janeiro has used this system, but has changed or is about to change to system II.

from that of the French 819-line system since here equalizing pulses and normal vertical sync pulses are used. The number of equalizing pulses has been increased to 7 as compared with 6 or 5 for other systems and a proportionate increase has been made in the vertical sync interval.

The synchronizing wave forms of these systems are compared in Fig. 2.

TECHNICAL CONSIDERATIONS

THE UNITED STATES, with a 60-cycle electric power system, uses 60 fields per second for its television pictures. Europe, with 50-cycle power, uses 50 fields. There are systems operating satisfactorily with 60 fields on 50 cycle power systems in Japan, Thailand, and parts of Latin America. The following paragraphs discuss factors affecting this choice.

Pictures produced at the rate of 25 per second can be only 16 per cent as bright as those produced under identical conditions at the rate of 30 per second, before the threshold of flicker sets in. However, they can have 20 per cent (30/25 = 1.20) more detail per picture for the same video bandwidth because the information capacity can be used for detail instead of repeating detail already displayed. It appears wrong to many engineers to pay a permanent 20 per cent loss in picture detail just to satisfy the flicker sensitivity of the eye which may be satisfied at a much lower cost. Thus, for example, slow-decaying phosphors, such as those now used in the United States in color television, can produce bright pictures with little flicker although with some blurring on fast motion.

Standard motion picture projectors which normally show 24 pictures per second can be used directly on television systems which transmit 25 pictures per second since action need only be speeded up by 4 per cent. The use of motion pictures on television systems using 30 pictures per second is more complicated.

All television systems now in use are capable of operating when not synchronized to the electric power line because small differences, of less than 1 cycle, between the power frequency and the field frequency can be easily tolerated. However, differences of 10 cycles, which would occur if 60 fields were used with 50-cycle power (or vice versa), introduce difficulties such as flicker and moving spurious patterns. While these difficulties can be and have been minimized by adequate hum filtering of transmitters and receivers, this remedy increases the cost of all receivers. Some trouble still persists when the scene is illuminated from a single-phase source whose frequency is appreciably different from the field rate such as might occur in outdoor night pickups.

MULTIPLICITY OF STANDARDS

THE MULTIPLICITY OF STANDARDS results in difficulties with frequency allocation, with the exchange of programs, and complicates those receivers which must receive pictures on multiple standards.

When systems require different channel bandwidths, it is difficult to work out an allocation plan without overlapping some channels. This can produce interference in the overlapping region. Thus, a French 14-mc channel requires as much spectrum space as two of its neighbors' channels which use only 7 mc. The interference that can arise from this situation is demonstrated in Fig. 3. This shows the frequency relationships between a station in Koblenz, Germany, and a station in Guebwiller, Alsace, France, approximately 165 miles apart. The German sound carrier S_K can produce a 1.2-mc beat note in French pictures. To a lesser degree, the French picture carrier P_G can produce a 4.3-mc beat note in the German pictures. The addition of a color subcarrier to the German station (shown as C_K in Fig. 3), can introduce an annoying 200-kc beat note in receivers tuned to the French station. Likewise, the French picture carrier P_G can interfere with the reception of colored pictures near Koblenz. Since Koblenz uses 625 lines, and Guebwiller uses 819 lines, offset carrier operation cannot be used to reduce the visibility of the interference.

Differences of standards complicate the international exchange of programs. Special techniques are used in Europe where such exchanges are quite frequent. Awkward as it is to exchange programs between systems having the same number of pictures per second and different number of lines per picture, as is the case in Europe, it is even more difficult where the number of pictures per second differs (25 and 30) as is the case in Latin America. One form of standards converter used in Europe uses a cathode ray tube to reproduce the received television picture which is scanned by its own standards. A camera, scanned on the standards to be transmitted, picks up the reproduced picture for retransmission. This technique, while relatively complex, results in remarkably good pictures. Exchanges now occur frequently between almost all countries of Western Europe. Exchange of programs between countries employing different numbers of pictures per second appears to require devices using information storage such as film or tape.

Belgium, with two sets of standards of its own, illustrates the difficulties of multiple standards. Receivers in Belgium can receive programs from France and the Netherlands whose standards differ from each other and differ also from the two Belgian standards. One result is that television sets sold in Belgium must be equipped with at least a two-position switch to receive the two Belgian standards but preferably with a four-position switch to receive all available programs. The same situation exists to a lesser extent in Luxembourg, and along the borders of France. The functions performed by the "standards switch" can be seen by comparing columns IV, VI, VII, and VIII in Table I which lists the characteristics of the different systems. Briefly referring to the table it is seen that

1. Synchronizing circuits adapted to each system must be switched.
2. The video polarities must be reversed in going from system IV to systems VI, VII, and VIII (or vice versa).
3. The scanning frequency must be lowered in going from systems VI and VIII to systems IV and VII.
4. The video bandwidth must be reduced in going from system VI to systems IV, VII, and VIII.
5. The sound system must be changed from FM to AM in going from system IV to systems VI, VII, and VIII.

The 14-mc bandwidth, required by French standards, seriously reduces the number of channels available wherever this system is used. To provide an adequate number of transmitters, the French have resorted to the so-called "tete-beche" scheme. In this scheme, shown in the lower part of Fig. 1, one section of the radio spectrum is shared by two channels whose transmitters are separated geographically. The relative position, within the passband, of the picture and sound carriers of station *1* are the inverse of the relation for station *2*. Only the low energy (high

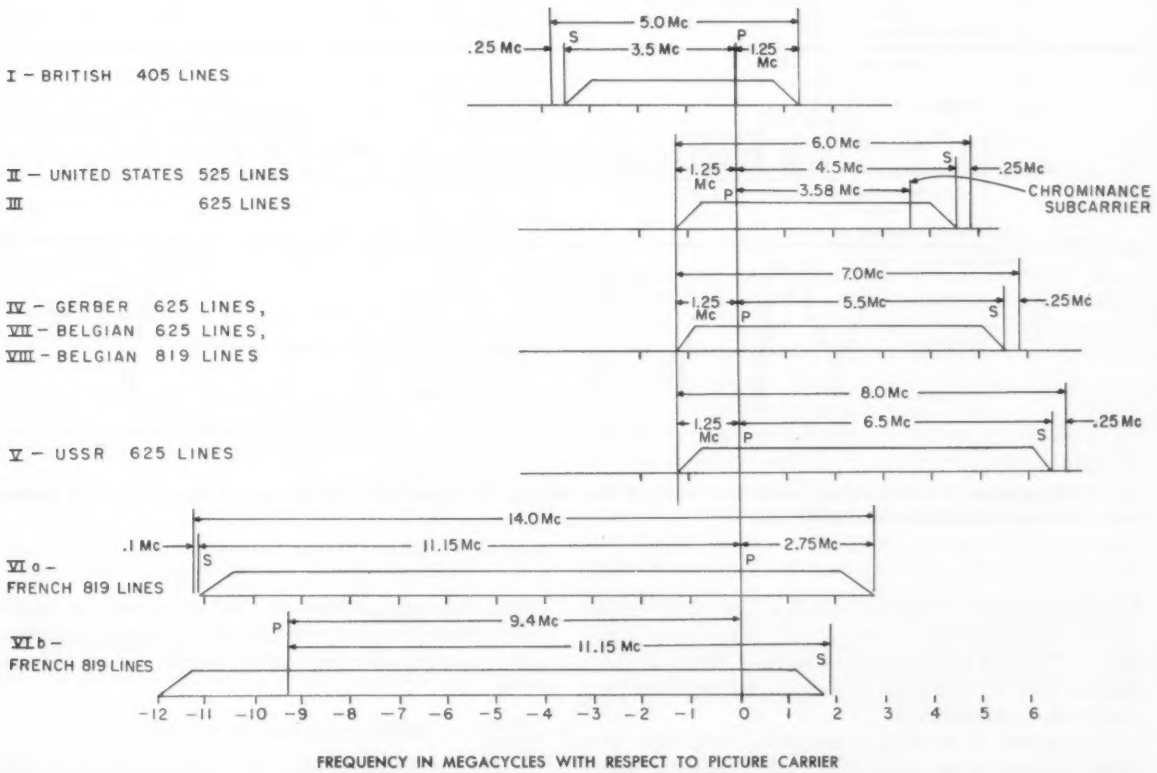

Fig. 1. Channel arrangement for various systems; S = sound carrier frequency, P = picture carrier frequency

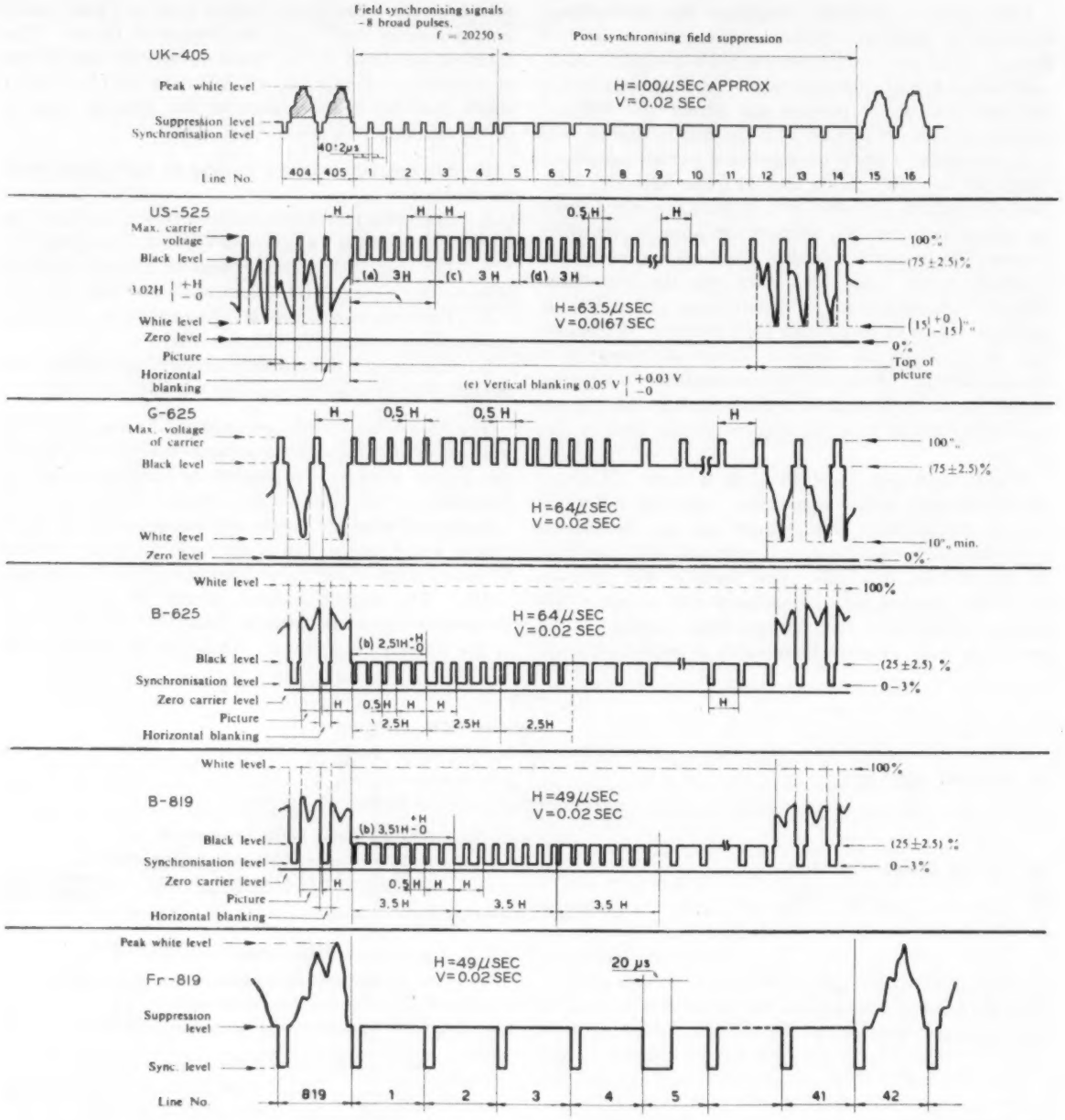

Fig. 2. Comparison of synchronizing wave forms (end of even fields). H = duration of one line scan, V = duration of one vertical scan. (Time and amplitude not to scale)

frequency) picture components of station *2* can interfere with the low frequency high energy picture components of station *1*. The low frequency components of station *2* which interfere with the fine detail of station *1* can be filtered out at the cost of the fine detail.

This scheme is capable of producing very high resolution pictures in the vicinity of each transmitter where the interference is low and results in reduced picture detail as the receiving location approaches the interfering station. Recent tests seem to show that the interference is appreciably greater than had been calculated with the result that interference-free coverage is more limited than had been expected.

FREQUENCY BANDS ASSIGNED

In 1947, the Atlantic City (N. J.) Convention and subsequent regional authorities allocated the frequency bands shown in Table IV for television broadcasting.

Table III. Comparison of Performance of Different Television Systems

System: / Name of System:	I British	II United States	III	IV Gerber	V U.S.S.R.	VI French	VII Belgian 625	VIII Belgian 819
Number of Lines	405	525	625	625	625	819	625	819
1. Relative Channel Bandwidth	0.84	1	1	1.17	1.33	2.33	1.17	1.17
2. Relative Brightness for Threshold of Flicker	0.16	1	0.16	0.16	0.16	0.16	0.16	0.16
3. Maximum Available Video Bandwidth, Mc (Picture Carrier to Sound Carrier Spacing)	3.5	4.5	4.5	5.5	6.5	11.15	5.5	5.5
4. Relative Number of Picture Elements per Picture	0.93	1	1.2	1.5	1.7	3.0	1.5	1.5
5. Relative Vertical Resolution	0.8	1	1.2	1.2	1.2	1.6	1.2	1.6
6. Relative Horizontal Resolution	1.2	1	1	1.2	1.45	1.9	1.2	0.93

RELATIVE PERFORMANCE OF THE DIFFERENT SYSTEMS

THE PERFORMANCE of the different systems is compared to that of the United States 525-line system in Table III.

The wider the bandwidth of each channel, the fewer the number of channels which can be accommodated. Also, other things being equal, receivers with wide bandwidths cost more. Only the 305-line system is more economical of bandwidth than the 525-line system (Item *1* of Table III).

The brightness at which flicker just appears can be determined from the Ferry-Porter law. Under equal viewing conditions pictures viewed at 50 fields can only be 0.16 as bright as those viewed at 60 fields (Item *2*).

The total number of picture elements per picture is proportional to the video bandwidth divided by the number of pictures per second. Table III shows that all systems have more detail than the 525-line system except the 405-line system, which is quite close (Item *4*).

The vertical resolution is proportional to the number of lines if blanking is neglected. Again we see that all systems except the 405-line system are superior in this respect to the 525-line system (Item *5*).

The horizontal resolution is proportional to the video bandwidth multiplied by the duration of one line. All systems are at least equal in this respect to the 525-line system except the Belgian 819-line system, which is quite close (Item *6*).

It should be pointed out that, although there are rather large apparent differences among systems with regard to detail and resolution, these differences are actually of less importance than indicated due to subjective effects in viewing pictures.[1]

Table IV. Frequency Allocations for Television Broadcasting
(Frequencies in Megacycles)

	Band I	Band III	Bands IV & V
Region 1			
Europe, U.S.S.R. inside and outside Europe, Mongolia, Asia Minor, Africa, and additional out-of-band frequencies for:	41–68	174–216	470–585
France		162–174	
Italy	81–88		
Belgium, Germany, Switzerland		216–223	
Region 2			
Western Hemisphere including Hawaii	54–72 76–88	174–216	470–890
Region 3			
Oceania, Asia (less parts in Region 1)	54–68 76–88	174–216	470–585 610–940
Australia	49–56 63–70 85–92 132–146	174–202 209–216	500–855

ADDITION OF COLOR

ALL SYSTEMS can support the addition of a color subcarrier except the French system when it uses the "tete-beche" scheme. There is a possibility of interference when a non-French transmitter emits color in the vicinity of the French frontier as is discussed previously (Fig. 3). Inasmuch as all systems have greater horizontal resolution than the 525-line system, the color subcarrier can be placed at a relatively higher frequency than in the United States. This will result in lower visibility of the interfering dot pattern, or conversely greater luminance resolution.

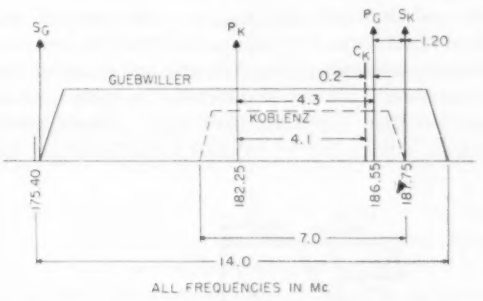

Fig. 3. Potential interference between systems

The 7-mc (and 8-mc) systems, except the Belgian 819-line system, might well use their large video bandwidth to achieve better compatibility and simpler color circuits than in the United States. This could be done by choosing a color subcarrier frequency which is about half a megacycle higher (1 mc for the 8-mc system) than the United States standard of 3.58 mc. This will result in better compatibility and luminance resolution by reducing the overlap between the luminance and chrominance signals, and simpler color receiver circuits by allowing essentially symmetrical sidebands for both components of chrominance.

REFERENCE

1. The Subjective Sharpness of Simulated Television Images, **M. W. Baldwin, Jr.** *Proceedings*, Institute of Radio Engineers, New York, N. Y., vol. 28, October 1940, pp. 458–68; also in Bell System Technical Journal, New York, N. Y., vol. 19, October 1940, pp. 563–86.

A Method of Making Screen-Room Measurements

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A NEW METHOD for measuring radiated interference by the use of a screen room has been developed. The screen room, by providing an electromagnetically noise-free region, permits the measurement of weak radiation in laboratory and factory areas. Accompanying this improvement in measuring sensitivity is the problem of dealing with the multiple reflections created by the metallic boundaries.

It was, therefore, the object of this method to make use of the metallic boundaries rather than requiring the use of empirical procedures to account for their presence. This measuring system relates the screen-room measurements to the corresponding "free-space" field intensities in such manner that the "free-space" radiated fields from interfering equipment can be determined without actually making field-intensity measurements.

An analysis of radiating equipment has indicated that the radiated fields from such equipment could be generated by a properly oriented system of electric and magnetic dipoles. Furthermore, if the size of the radiating equipment is very much less than the wavelength under consideration, the system of dipoles can be reduced to one resultant electric dipole and one resultant magnetic dipole. These results are the basis of the screen-room measuring procedure developed.

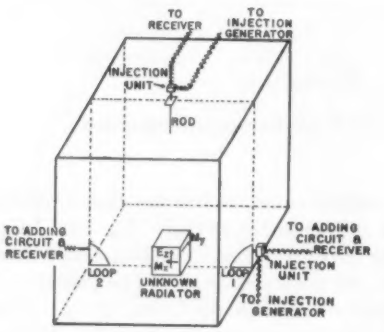

Fig. 1. Arrangement of pickup probes for making measurements on a grounded radiator

The dipole moments of radiating equipment are determined by appropriately locating the equipment in a screen room. The screen room is treated as a cavity, which is excited internally by dipoles whose frequency of excitation is kept below the lowest resonant mode of the room. A system of pickup devices located on the inside surfaces of the walls are used to provide data on the type (magnetic or electric), strength, and orientation of the dipoles present. The pickup system consists of both loop and rod probes appropriately located and polarized in such a way that components of the electric and magnetic dipoles present can be individually detected (Fig. 1). In this manner, by proper rotation of the pickup system or the radiator, all the components of each type of dipole can be detected. The strength of the detected dipole components are measured and then correlated with the electric field that such components would produce in "free-space" (over a ground plane) at a specified distance. The vertical electric field was considered as the optimum measure of interference for the particular applications of the U. S. Army Signal Corps, but this system is not limited to the consideration of only this field component.

To accomplish the actual measurement, the pickup system of the room is initially calibrated by the use of electric and magnetic radiator standards. By creating known dipole strengths at specific locations in the room, the corresponding induced pickup voltages are measured as a function of frequency by means of pickup-probe injection circuits.

Therefore, the pickup system of the room is calibrated so that the dipole moment components of unknown radiating equipment can be determined. From field equations, the vertical electric field corresponding to the resultant dipole moments (both electric and magnetic) are obtained for a specified distance from the radiator. This procedure makes it possible to correlate the induced voltages in the room pickup probes to "free-space" field intensities.

The method of measurement has certain definite limitations. First the size of the radiator and pickup probes must be small in comparison to the room size (less than one third). This limitation is required because the method of measurement is based upon the concept of point sources and probes. Second, the size of the radiating equipment must be small compared to the wavelength of measurement (less than $\lambda/10$) so that the equipment will possess a dipole radiation pattern. Third, the frequency of measurement should be below the lowest resonant mode of the room (approximately one half the frequency). For some cases, it is possible to exceed the first limitation for the radiator if a greater tolerance in measurement is allowable.

This method of making screen-room measurements should prove to be particularly useful since it is capable of providing essential field-measurement data in an electromagnetically noisy region. Furthermore, a measurement of radiator equivalent dipole moment provides information from which the resultant field intensity at any distance can be computed for any radiator arrangement. Finally, it is recommended that interference specifications be established using this method of screen-room measurement as a standard.

Digest of paper **55-737**, "A Method of Making Screen-Room Measurements," recommended by the AIEE Committee on Instruments and Measurements and approved by the AIEE Committee on Technical Operations for presentation at the AIEE **Fall** General Meeting, Chicago, Ill., October 3-7, 1955. Published in AIEE *Communication and Electronics*, January 1956, pp. 746-50.

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Experience in D-C Testing of High-Voltage Stators

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IN 1952, the-resistance-versus-direct voltage (R/V) test[1] was proposed as a means of measuring, nondestructively, the breakdown voltage of damaged insulation.

Since then, the test has been applied to 25 Ontario hydro machines of all types, rated 6.6 kv to 13.8 kv, to provide information on stator insulation for maintenance purposes. Reassurance has been obtained as to the intactness of the groundwall in most of these cases. Reference characteristics have been established for healthy insulation by testing new machines after the thorough drying-out that is achieved only after a period of operation. In a few cases, breakdown voltage has been indicated as somewhat below or just above the standard level, which at present is set at 28 kv direct current for the 13.8-kv machines and prorated for the others. So far, there has been no unintentional breakdown on test, and there has been no service failure of insulation which had been indicated as sound by the test. Stators in which the R/V test has indicated weakness are usually kept in service and accorded appropriate priority for rehabilitation; their performance is providing a basis for adjustment of the standard of insulation strength to the optimum level for reliability and economy.

The R/V test is performed by applying a direct voltage of approximately 60 per cent of the standard level, and then approaching that level by applying five or six successively smaller increments. At each voltage step, sufficient time is allowed for dielectric absorption to become negligible, the current taken by each phase of the winding is then measured, and the corresponding resistance plotted against voltage. A test can therefore be performed in 2 to 4 hours unless adverse indications require investigation. Approach to breakdown voltage of the weakest point in any phase is signalized by a deviation, either downward or upward, from the form of R/V characteristic for intact insulation. If the deviation is a downward curvature, it can be extrapolated, continuing the curvature, to give a sufficiently accurate indication of breakdown voltage at intersection with the voltage axis.

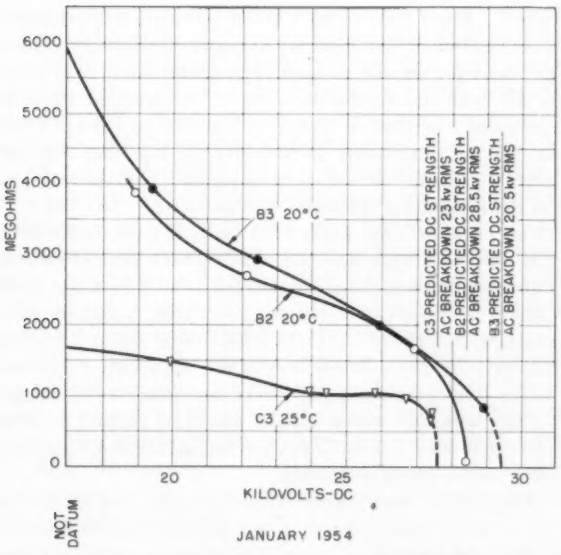

Fig. 1. Research tests on water-wheel generator rated 40 megavolt-amperes, 11 kv, 138 rpm, with asphalt-mica insulation, after nearly 30 years' moderately heavy loading, showing comparison of predicted and actual a-c breakdowns

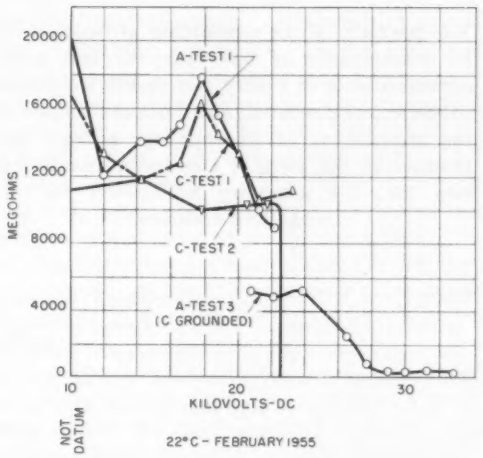

Fig. 2. Research tests on water-wheel generator rated 36 megavolt-amperes, 6.6 kv, 100 rpm, with shellac-mica insulation, after nearly 30 years' normal loading, showing difficulty of prediction and dubious significance of breakdown voltages after exposure to dry atmosphere

Fig. 1 exemplifies results of a research test on a condemned winding, in which predicted d-c strengths are compared with actual a-c breakdowns. Fig. 2 illustrates the unreliable results obtained on a winding which had unduly high insulation resistance, owing to extreme dryness of the ambient air. Best results have been obtained on windings cooled to ambient temperature while exposed to air of over 60-per-cent relative humidity.

As with a d-c or a-c withstand test, the significance of the breakdown voltage lies in its indication of the degree of disintegration at the weakest spot in the winding.

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1. Diagnoses of A-C Generator Insulation Condition by Nondestructive Tests, **A. W. W. Cameron**, AIEE *Transactions*, vol. 71, pt. III, 1952, pp. 263–74.

Digest of paper **56-45**, "Experience in D-C Testing of High-Voltage Stators," recommended by the AIEE Committee on Rotating Machinery and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 30–February 3, 1956. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1956.

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Brainpower—Our Greatest Asset

F. H. BOWLES

The problem of the availability of brainpower for maintenance of our economic and social organization is in reality two closely connected problems, as discussed, and both are related to the question as to whether our colleges can produce in the form of engineers, administrators, etc., the necessary brainpower for our expanding economy.

THERE ARE TODAY two separate problems related to brainpower. The first of these has to do with the present operation of our educational system which seems to be failing to hold, to the point of maximum return, a very large number of able individuals; this is an immediate problem. The second has to do with the ability of our educational system to double its capacity within the next decade. This is an organizational and administrative problem which must be dealt with for the next generation; it is not immediate, but is obvious and will become pressing.

The two problems are both related to the question of whether our schools and colleges can produce in the form of workers, technicians, engineers, scientists, and administrators, the brainpower necessary to keep our economic and social organization going.

EXPANSION OF EDUCATION AND ECONOMY

THIS QUESTION concerning brainpower is one which is being posed in many forms, and to which different answers are today being given. Large corporate scholarship programs are one set of answers. The Ford Foundation's recent dramatic gift was, in effect, an answer to the question, which said, "No, not without help," and then proceeded to suggest a form of help. The Ford Foundation answer, considered apart from the gift which accompanied it, was sheer common sense. It is an answer to be found by anyone who compares the money that will go into development and expansion of our industrial and commercial structures, with the money that is scheduled to go into development of education. The impression from newspaper accounts and stockholders reports is that over the next decade many billions of dollars are to be spent for commercial and industrial expansion. Also, the impression, as to the money planned and available for educational expansion, is that it is only a small and a disproportionately small fraction of that amount. Hence, the only common sense answer, based merely on a comparison of announced plans, is that education will not expand commensurately with industry and commerce unless steps are taken which are not now in process of planning. Now, if this is the answer, then it has important implications for further expansion of our economy, for there is a direct relationship between expansion of education and of the economy.

What this means, of course, is that from each dollar spent in production, whether it be in direct costs or overhead, a certain fraction has to go for the purchase of brainpower. If this fraction can purchase a constant amount of brainpower, then productivity per man can be maintained. If it can purchase increasing amounts of brainpower, productivity per man goes up. If it can purchase only diminishing quantities of brainpower, productivity goes down. If brainpower is priced out of the market, we turn to substitutes or to ways of multiplying what we have through the use of multiplying equipment.

This is, of course, a subject that threatens to move into the higher realms of economics; if it should do so, almost everyone of us would be lost in a jumble of special terms and special techniques. However, a good deal can be done with it with the ordinary facts available to all of us, and these are the ones on which to rely.

CHANGING LABOR FORCE

THE FIRST OF THESE FACTS is that education has, during the last 50 years, been performing two functions that have brought about a steady increase in productivity per man. The first of these functions has been the progressive removal of youth from the labor force; as to this, there is no possible doubt. From 1900 to 1950 our labor force has expanded from just under 30 million to just under 60 million. During the same period, the number of individuals under 21 years of age who are in the labor force has dropped from an estimated 8 million in 1900 to 5.7 million in 1950. These figures are interesting in themselves, but they become meaningful only if they are compared with school and college enrollment figures for the same dates. In 1900, only 11 per cent of the age group 14–17 were in secondary school, and only 4 per cent of the age group 18–21 were in college. Put into numbers, these percentages mean that of the 12.06 million in these two age groups, less than a million were students, and therefore, 11.13 million were not in school or college. By 1950, 76 per cent of the age group 14–17 and 30 per cent of the age group 18–21 were in school or college. In numbers, this meant that of the 17.37 million in these two age groups, 9.05 million were students, and 8.32 million were not in school or college.

It should be noted, quite parenthetically, that those who try to set up involved social and psychological theories to explain the quantity of juvenile delinquency or misbehavior might simply ponder the fact that over 9 million, constituting more than half of all individuals age 14–21, are in school today with all the leisure time at their disposal that

Full text of an address presented before Engineers Joint Council General Assembly, New York, N. Y., January 26–27, 1956.

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they can extract from school pursuits, whereas in 1900 fewer than 1 million, or considerably less than 10 per cent of those in the same age range, were enjoying the considerably less leisure than available to students. Even as late as 1930, fewer than one third of the age group 14–21 were in school and college. This may mean that what is called a wave of juvenile misbehavior today is at least, in part, merely the expression of the hell-raising potential of the semileisure class that has been created by holding our children in school. But, parenthesis aside, the fact is that the development of education has removed a large number of workers of relatively low productivity from the labor force.

EDUCATION REPLACES APPRENTICESHIP

THE OTHER FUNCTION performed by education has been, in simple terms, the replacement of apprenticeship by education. In his excellent paper on technical institute as a service for business and industry, Don Metz, director of the Technical Institute, Dayton, Ohio, pointed out that each of three great wars has fostered a major educational development related to business and industry—the land-grant colleges emerging from the Civil War, vocational education and the Smith-Hughes Act emerging from World War I, and the Emergency War Training Program leading to the technical institutes being developed during World War II. Actually, these developments on the technical level were matched by higher education which, beginning about 1910, has devoted an increasing percentage of time and resources to occupational training—business, nursing, and other health occupations, and an ever-increasing variety of service-training programs. This can be shown by quoting any number of statistics, but one set will do—there were no degrees in business listed in the 1910 returns on degrees granted. By 1950, business degrees comprised 20 per cent of all degrees granted in the nation. Similar facts can be adduced in other areas where education has demonstrably replaced apprenticeship. The net result of this second function of education is that, in addition to withholding from the labor force a very large group of workers of low immediate productivity, education is also releasing annually into the labor force a very large number of workers with an immediate high-productivity potential.

Up to now, this has been a very satisfactory form of operation. The individuals under 21 years of age, who were in the process of being educated, were making their double contribution to the statistics on productivity by being withheld from the labor force during a period when their productivity would have been minimum, at the same time that they were being prepared for maximum productivity.

Year by year, the size of the group increased both absolutely in numbers and relatively in terms of the size of the labor force. This meant, therefore, that the process of developing manpower into brainpower—insofar as this can be done through formal education—operated with very satisfactory results. Also, the statistics show that during this period, productivity per worker increased.

BRAINPOWER RESERVE

DURING THE PERIOD when all this was happening we were, in effect, drawing upon a reserve of brainpower, which consisted of those individuals under 21 years of age who were not in school or college. As of 1900, this was a very large reserve, both numerically and in relation to the labor force. Today, the reserve is far smaller numerically and percentage-wise is smaller still.

There will, of course, be those who think that 8-million people are a lot of people and that a reserve composed of that number of individuals not in school or college is pretty large; actually, this is not so. Our secondary schools are already dealing with most of the 14–17 age group and are steadily developing their holding power, which means that there are very few additional in that group now available for more education. It can be expected that within a short time 90 per cent of all possible secondary-school students will be in secondary schools. The remaining large reserve is in the 18–21 age group. This reserve now numbers about 70 per cent of that group or, roughly, 6 million. But, in considering this group, the limiting factor is that the level of college work is, or should be—in terms of present definitions—pitched in terms of the upper half of secondary school graduates. To put this another way—our reserve of brainpower available for further education in this group will be exhausted by the time that half of this age group is in college. This time is not very far off; in terms of present college-going pressures, it may be only 10 years away.

All of this adds up to the fact that our reserve of educated brainpower is running short. Also, it is running short at the exact time when tremendous new technical developments are about to make an unprecedented drain on our brainpower. It is true that these technical developments in electronics and in atomics carry with them the eventual promise of new machines and equipment, which may reduce the demand for brainpower. For that matter, some of them may be able to eliminate all of our problems in one grand and noisy elimination. But until these new developments are mastered, we shall need much more brainpower.

COLLEGE BOARD SURVEY

IT IS THIS FACT that we are running short of brainpower that has aroused our interest in the development of human resources that have hitherto been unregarded. Recently, the College Entrance Examination Board completed a study to find out how large this quantity of undeveloped brainpower is now. It was decided, more or less arbitrarily, to concentrate attention on the top 30 per cent ability-wise of high-school seniors; the size of this group is 365,000 students. Through questionnaires submitted to a sizable sample of this number, it was determined that 165,000 of these were planning on college immediately, and another 96,000 were planning on college later. Also, 21,000 were interested in college, but had no plans, and 51,000 had no interest. In addition, about 10 per cent of our sample did not make useful responses to the questionnaire and could not be classified. The presumption must be that most of them fall into the "no interest" category. There are various combinations of ways in which these responses may be treated but, considering all factors, it is probably not far wrong to say that from this high-interest group approximately 100,000 would like to go to college, and that perhaps half of them will manage to do so although not all of them will finish.

The other 50,000 who are interested in college will not go, and 100,000 with no interest will not go either, which means in total that out of our top 30 per cent in ability not over 215,000, or just under 60 per cent, will go to college, and 150,000, or just over 40 per cent, will not go to college.

These figures give some measure of the size in any given year of the group which must necessarily supply the bulk of our brainpower. We are all aware, also, that not everyone in the 365,000 who shows academic ability will, in fact, use his ability to capacity, regardless of whether he is one of the 215,000 to go to college and, likewise, that men who will later show outstanding ability are not included in the group. But, by and large, the size of this group measures the best of our brainpower resources. For the purposes of the Engineering Manpower Commission, it is worth knowing that 41 per cent of the boys in the group wish to study science and engineering. It is also worth knowing that among the boys 46 per cent would have preferred more high-school mathematics than they actually studied and 35 per cent would have liked more science. These are comforting figures in the sense of showing a degree of maturity on the part of the students; they are not comforting to the extent that they describe the programs actually followed by these students. It is less comforting to know that only 53 per cent of the high-ability boys interested in engineering and only 57 per cent of those interested in science and mathematics planned to enter college immediately.

HIGH-ABILITY STUDENTS

In quoting these statistics, there has been omitted pages of breakdowns dealing with a wide variety of facts about this top 30 per cent, as well as about the 70 per cent of the study group for whom I have quoted no figures, in order to emphasize two facts:

1. Our brainpower group is not large; if it is defined as the upper 30 per cent ability-wise in any given age group at any time up to age 21 years, it numbers less than 700,000 boys and girls. Out of this group only about 200,000 will finish college. Although it may be argued that the 500,000 who leak out of the education process are making contributions to the nation's well-being, it is nevertheless clear that they will not as a group contribute up to their full potential.
2. The number of the high-ability students who graduate from college cannot under present circumstances be increased greatly. Extreme measures, such as a tremendous scholarship program and intensive guidance, might increase the number of college graduates from 200,000 to 250,000. In round figures, this would increase the number of scientists and engineers by, at the most, 12,000 a year.

From these facts, it is clear enough that no great quantity of salvation is to be expected from efforts to stimulate the increase in the output of educated brainpower through devices such as scholarship programs. There will be some results, of course, but they will not be startling nor, except for huge sums of money, numerically important.

SOLVING BRAINPOWER PROBLEM

This brings up the question of whether the brainpower problem will not solve itself through the rising tide of students, we hear so much about. It is a known fact that the college-going population will double within 15 years. Will not the new increment to our brainpower solve our problems of numbers? The answer to this question is like the answer of the man who was asked if his consumption of 21 cups of coffee a day keep him awake. He said, "It helps." Beyond that it is hard to go, for there are certain important facts:

1. The leak in our educational system, through which over 60 per cent of our best brainpower is now disappearing, has not been plugged. When we double numbers we will double the number who leak away.
2. Although the probability is that ways of handling our doubled numbers will be found, no one is yet clear what they are. It is certain that we cannot handle doubled numbers and improve our performance at the same time. It is more than probable in fact, that our performance and standards will drop off from their present level.
3. The youngest and brightest war babies are still 6 years away from their degrees. The first large groups of war babies are 10 years away from theirs, and the really heavy sustained pressure will not come until after 1965.

However, there are some bright spots to be considered; these are:

1. There are some signs that interest in mathematics, science, and engineering is on the upturn. It will not solve the problem of numbers, but it will help and it will restore a balance that had been lost.
2. There is a good deal of reason to hope that the current concern with full use of human resources will lead to improvements in selection instruments and selection techniques. If this happens, there may be three desirable results: (a) better guidance in secondary schools, which should encourage more able and qualified students to remain in student status; (b) better selection of students for engineering and scientific programs; such selection might, by increasing the holding power of these programs, be the equivalent of the founding of a number of new scientific and technical institutions, as has happened in medical education with exactly those results; and (c) better information about and better guidance with respect to technical institutes and community colleges.

THE FUTURE

The temptation to go into analyses and discussions about brainpower and its uses can lead into almost endless vistas of time and space, for there is no end either to problems or solutions—barring the neat solutions of Aldous Huxley in "Brave New World." The question of whether to be encouraged or discouraged about the future is one for each of us to settle according to his own understanding and beliefs. But, regardless of how we settle the question for ourselves, or plan for others, it should be a matter of some comfort that we are dealing in the last analysis with the question of how maximum education can be provided for all of our youth. So long as this is a question that is of equal concern to business, industry, and education, the prognosis, both for our youth and our nation, is favorable.

A Rural Distribution Voltage of 14.4/24.9 Kv

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SINCE 1948, some 75 Rural Electrification Administration (REA) borrowers have constructed rural distribution systems which operate at 14.4/24.9 kilovolts (kv), grounded wye. Most of this construction has been in the sparsely settled areas of the South and Southwest where a number of factors combine to make the use of this voltage very attractive.

The reason for using this voltage in low density rural areas is basically one of economics. The over-all cost, including transformers, of a new 14.4/24.9-kv system is about 20 per cent higher than an equivalent new 7.2/12.5-kv system, assuming the same conductor size and phasing. For this additional investment, however, 4 times the line capacity is obtained and on this basis, the construction cost per kw of a 14.4/24.9-kv system is only 30 per cent of an equivalent 7.2/12.5-kv system, assuming typical rural conditions.

Consideration is given to the use of 14.4/24.9 kv on systems which would otherwise require exceptionally long distribution feeders, transmission line, large feeder capacity, additional substations, etc. Economic considerations and service reliability are the principal factors entering into a study of the use of 14.4/24.9 kv or 7.2/12.5 kv for a specific system.

The earliest 14.4/24.9-kv systems used 15-kv class equipment. However, the probability of overvoltages occurring under line-to-ground fault conditions made it desirable to use lightning arresters with an 18-kv rating. This, in turn, has led to the development of distribution transformers and other equipment of a new 18-kv class, now used predominantly.

Basic construction practices of the REA program for 7.2/12.5-kv lines have been followed in all 14.4/24.9-kv construction. The earliest 14.4/24.9-kv designs were patterned after the 7.2/12.5-kv systems.[1] However, operating experience led to a number of modifications in design to meet the special requirements of distribution at 14.4/24.9 kv.[2]

The major equipment problem experienced has been the excessive generation of radio noise in the areas served. The use of "radio freed" insulators was a ready solution for line insulator noise. In other cases, however, it was necessary for manufacturers to make design changes to bring their equipment within tolerable noise limits. This experience led to the adoption of a very rigid specification for permissible radio noise. Equipment is now available which is within tolerable limits.

As in the case with equipment, radio noise proved to be the most severe problem common to the early 14.4/24.9-kv system designs. These designs were patterned after the 7.2/12.5-kv systems and the same basic clearances were followed. However, where 2 inches of wood between ground and hardware associated with energized parts was adequate for 7.2/12.5-kv construction, this clearance resulted in electrically overstressing the wood insulation of the pole at 14.4/24.9 kv and was the cause of excessive radio noise. It was found that a minimum of 12 inches of wood between ground and hardware associated with energized parts was necessary to limit radio noise to satisfactory levels. To obtain this clearance, pole top designs were revised to specify wood crossarm braces for some assemblies, to move guy wire locations and crossarms, and to use a horn gap rather than a ground wire extension for pole protection purposes.

High charging currents have been the cause of operating difficulties on several systems. Excessive line losses, overloaded substations, high voltages, and unstable operation of small generating plants have been experienced occasionally. However, these difficulties have been the exception rather than the rule and, on the average, 14.4/24.9-kv system charging current has not been a severe problem. Where corrective measures have been required, shunt reactors have proved to be a practical solution.

Voltages to ground as high as 3 times normal have been experienced occasionally on 14.4/24.9-kv systems following the opening of one or two phases of a 3-phase circuit serving a wye-delta connected transformer.[3] Damage to lightning arresters and other equipment has been caused by these overvoltages.

This problem is not severe, and widespread damage has not occurred because a very small amount of load on either the transformer bank or the open phase or phases will suppress the overvoltages. For overvoltages to be established, both the transformer bank and open phase or phases must be without load and there must be no fault on the open phase or phases. Where this condition appears probable, the recommended solution is to connect the tap feeder serving the 3-phase load solidly to the main circuit rather than through fuse cutouts or other sectionalizing devices. In this way, the load on the main feeder is used to damp the ferroresonant circuit.

With a development such as this, it was to be expected that some new problems would arise. However, some of the more serious ones that had been predicted have not occurred. The use of this voltage has definitely been economical in the construction of new systems in territory that it is not feasible to serve at lower distribution voltages.

Digest of paper 56-3 "Operating Experience with 14.4/24.9 Kv as a Rural Distribution Voltage," recommended by the AIEE Committee on Transmission and Distribution and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 30–February 3, 1956. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1956.

L. B. Crann and **W. M. Edmunds** are with the Rural Electrification Administration, Washington, D. C.

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Simplified Printing Telegraph Switching and Integrated Data Processing

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Receiving and transmitting printing telegraph equipment generally requires some form of auxiliary equipment for switching and remote control. In many cases, this auxiliary equipment is complex, costly, and requires as much space and electric power as the controlled equipment. A new concept has been realized in the development of the Teletype Model 28 typing unit, which may be utilized to perform many electrical and mechanical functions for selective calling, remote control, integrated data processing, and other special functions.

THE MODEL *28* TYPING UNIT, shown in Fig. 1, is a completely new instrument designed primarily for high-speed printing telegraphy.[1] The unit is small in size, light in weight, and at a given speed of operation requires considerably less maintenance than normally recommended for apparatus of this type. This unit operates with greater ease and efficiency at 100 words per minute than conventional units at slower speeds.

THE TYPING-UNIT STUNT BOX

EVERY TYPING UNIT is equipped with a stunt box which controls the common functions, such as shifting the type box from lower to upper case, returning the printing carriage to the left-hand margin, line feeding, operating the signal bell, etc. In addition, the stunt box, as illustrated in Fig. 2, is capable of performing many electrical and mechanical functions.

The typing-unit selector responds to a start–stop 5-unit Baudot signaling code consisting of current and no-current intervals, referred to as marking and spacing impulses, respectively. The selector mechanism of the typing unit converts these electric signals into mechanical motions which are transferred to a set of code bars so as to: (1) control the position of the type box for printing the received character; and (2) determine the function performed by the stunt box.

The stunt box, located directly behind the code-bar assembly, has 42 slots, each of which will accommodate a function bar and its associated mechanism. These function-bar mechanisms can be employed, in conjunction with the code bars, to initiate a mechanical or electrical action within the machine or at a remote location. Fig. 3 is a rear view of the typing unit with the stunt box removed to expose the code-bar assembly.

The code bars are moved to the left or right in response to marking or spacing elements of the Baudot code. A series of square notches extend across the rear of each code bar. The front of each function bar contains a series of tines, which are formed to the left or right according to the marking or spacing pattern of the code combination to which the bar is to respond. The function-bar–code-bar relationship is illustrated in Fig. 4. The operation of any function-bar mechanism is dependent upon the position of the code bars when sensed by the function bars. If the position of the code-bar notches and function-bar tines match, the function bar will enter the recessed portion of the code bar and condition the associated function-bar mechanism for operation. The function bar, following its selection, is moved toward the rear of the typing unit performing a function dependent upon the arrangement of its associated mechanism. To change the code combination of any position in the stunt box only requires changing the function bar. The stunt box is readily removable to facilitate this change.

A simplified approach to many of the problems of switching and control is now possible using the Model *28* typing unit. Usage in such applications as selectively calling stations in telegraph networks and integrated data processing will be described.

SELECTIVE CALLING OF MODEL *28* PAGE PRINTER SETS

MANY TELETYPEWRITER NETWORKS are equipped to permit stations to call one another selectively. This operation, referred to as selective calling, may be accomplished in many ways. Some systems utilize discrete telegraph characters to select the desired stations, some employ pulse duration or pulse coincidence signal coding, while others use frequency or tone keying. Regardless of the method used, the selection of teletypewriter stations generally has required some form of auxiliary control apparatus. The Model *28* selective-calling typing unit utilizes discrete telegraph characters and requires no auxiliary control apparatus.

A review of the present usage of the Baudot code, as related to teletypewriters, will aid in understanding the operation and potential of the Model *28* selective-calling typing unit. The Baudot code contains five elements, each of which may assume a marking or spacing condition. This arrangement provides 32 distinct code combinations. All teletypewriters, however, are capable of performing approximately twice as many operations (printing or

Full text of paper **56-28**, "Simplified Printing Telegraph Switching and Integrated Data Processing," recommended by the AIEE Committee on Telegraph Systems and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 30–February 3, 1956. Scheduled for publication in AIEE *Communication and Electronics*, 1956.

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performing a function) as the number of available code combinations. This is accomplished by reserving two of the original code combinations to shift and unshift the platen (or type box in the case of the Model *28*), placing the unit in the upper or lower case as desired.

The Model *28* typing unit, when arranged for selective calling, is equipped with a device which activates or suppresses the printing mechanism. This arrangement permits an expanded use of the 32 code combinations of the Baudot code beyond that made available by the shift and unshift mechanism, since the unit can now be placed in a nonprint condition. In this condition, the selector and stunt box are active, but the printing mechanism is suppressed; consequently, the same code combination that resulted in the printing of two different characters (one in the lower and one in the upper case) may be used to perform two additional functions, either electrical or mechanical, without the typing unit printing. These additional functions are prevented from occurring when the unit is placed in the print condition by positioning an auxiliary code bar to block all function bars arranged to perform special functions.

Suppression of the printing mechanism is accomplished by blocking the type-box clutch. This blocking mechanism is controlled by elements in the stunt box, which are set up to respond to a particular character or character sequence. Reception of this character or character sequence causes the blocking mechanism to unblock the type-box clutch, placing the unit in the print condition. In this condition, the typing unit will operate as a normal teletypewriter. To return the unit to the nonprint condition, a character sequence differing from that which placed the unit in the print condition causes the blocking mechanism to block the type-box clutch. Code combinations selected for this latter sequence are preferably those which result in no printing.

The versatility of the Model *28* typing unit equipped with the blocking mechanism permits many variations of selective calling. The stunt box flexibility, as applied to selective calling, might best be illustrated by a brief description of two systems which are currently being placed in service.

Bell System Installations. Teletype Model *28* page printer equipment, now being placed in selective calling service by the Bell System, may be arranged to satisfy many diversified customer requirements. In their installations, each unit will shift to the print condition upon the reception of its preassigned character or sequence of characters, referred to as call directing characters (CDC). Units may be equipped to respond to more than one CDC, or character sequence, so that a group of units, or all units, on a circuit may be placed in the print condition by the transmission of a single CDC. In addition, all units respond to two common codes, an end of address and an end of message code; the first shifts all units to a nonselect condition, and the second places the units in a nonprint and select condition.

As previously described, the position of the blocking mechanism determines whether the unit is in the print or nonprint condition. This mechanism is controlled by the call-directing and end-of-message codes. The units will be in the select or nonselect condition depending upon the position of an auxiliary (lockout) code bar. This code bar is controlled by elements in the stunt box, which are set up to respond to the end-of-address and end-of-message codes. Reception of the end-of-address code causes the auxiliary code bar to be positioned to prevent selection of CDC function bars. Reception of the end-of-message code causes the auxiliary code bar to be positioned so as to allow selection of CDC function bars.

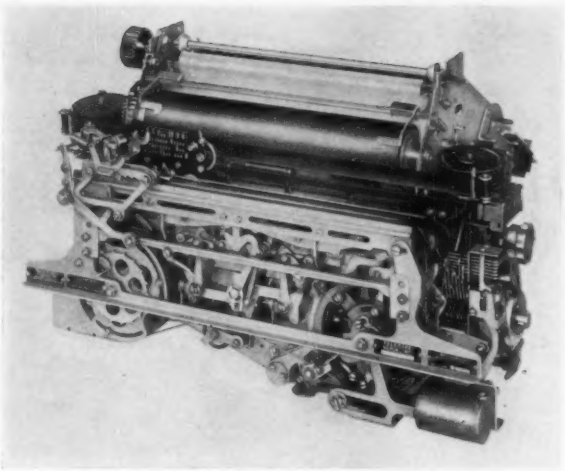

Fig. 1. The Model 28 typing unit

Any station desiring to communicate with one or more stations on the circuit may select them by transmitting his own and their assigned CDC. The end-of-address code sequence follows the transmission of the last CDC. All stations whether selected or not will have further selection suppressed, so that they will not respond to any selective-calling codes except the end-of-message code. CDC's may, therefore, be used indiscriminately in the message without causing false selections. All stations not called will have printing suppressed and, therefore, will receive none of the communication. At the conclusion of the communication, the end-of-message code sequence

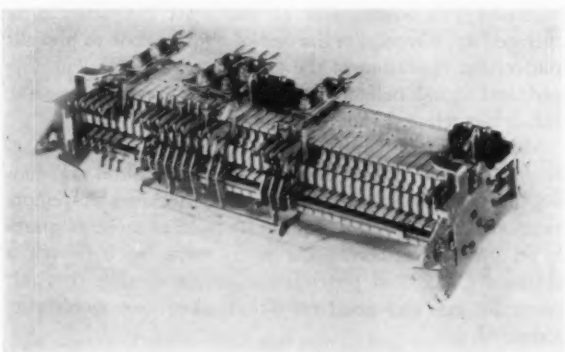

Fig. 2. The typing-unit stunt box

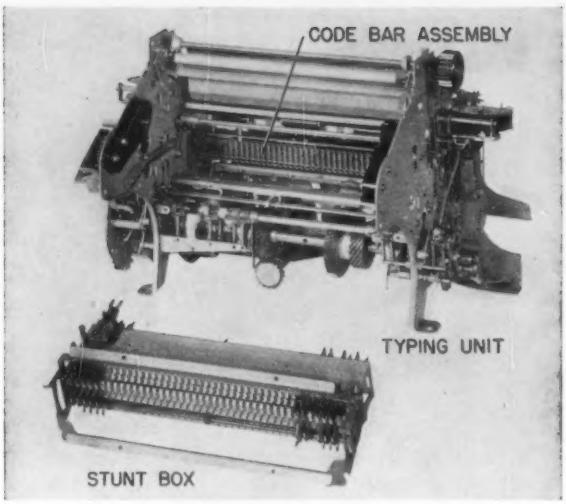

Fig. 3. Rear view of the typing unit with the stunt box removed

is transmitted, placing all units in the nonprint-select condition. In this condition, printing is suppressed and the stations are again capable of responding to CDC. The end-of-address code may be any character or character sequence. The end-of-message code, however, must be a sequence containing a minimum of two characters to insure that this code will not appear in the body of the communication.

The number of stations possible in a network depends upon the character sequence used for call direction. If the 26 code combinations of the alphabet are used, a single CDC will provide 26 different station calls. If a 2-character sequence is employed, a total of 676 different sequences are possible; a 3-character sequence will provide 17,576 different call-directing sequences.

The selective-calling stunt box arranged for Bell System service also performs the following auxiliary functions: (1) The first character received by each unit, following the end-of-message code sequence, causes a busy lamp to light on all units on the circuit; this lamp will flash each time a space character is transmitted whether the unit has been selected or not; (2) The copy lights of each unit are turned on only when the unit is selected; (3) The keyboard lock mechanism of the units not selected is operated upon receipt of the end-of-address code to prevent inadvertent operation of the keyboard; and (4) The line feed and signal bell operations are suppressed when the unit is not selected (nonprint condition).

Many optional features may be provided to meet particular customer requirements. These include the controlling of tape transmitters and reperforators at remote locations, motor control, equipping units to serve as spares in an installation containing many units, each having a different CDC, and providing a device to shift the unit manually into the print condition when line monitoring is desired.

Civil Aeronautics Administration (CAA) Installation. The CAA is installing a nation-wide selective-calling flight-control network, utilizing the Teletype Model *28* page printer set. This network consists of approximately 400 stations divided into 24 circuits. Each circuit contains from 10 to 30 stations, including relay stations for transmission to and from adjacent circuits. An expressway or trunk line is provided for transmission from coast to coast. The CAA installation and operating procedure differ from those of the Bell System. However, the Model *28* page printer sets are essentially the same, differing primarily in the stunt-box arrangements.

The CAA precedes the CDC with a 3-character code sequence that conditions the printer to respond to a station call. Upon receipt of the conditioning code, a mechanism in the stunt box positions the auxiliary code bar (lockout code bar in the Bell System units) to allow the station-call function bars to be selected. This code bar is held in the operated position for only the succeeding character. Consequently, if the first character of the station call does not follow the last character of the conditioning code the auxiliary code bar will return to its unoperated position, blocking the station-call function bars associated with the blocking mechanism. The combination of the conditioning code and station code is a sequence of six characters which would not normally appear in the message. Use of the conditioning code permits the selection of any station at any time during a communication without dropping out stations already selected.

Any station may communicate with one or more stations on the same circuit by transmitting the conditioning code and the desired station code. A selected unit is placed into the print condition upon receipt of the last character of the station code. An end of message sequence, similar to that employed in the Bell System installations, concludes the communication, placing all units in the nonprint condition.

To communicate with stations in adjacent areas requires the selection of a relay station in the circuit of the originating station. The relay stations contain reperforator-transmitter distributors controlled by Model *28* page printer sets. Both of these units are placed into the circuit upon the receipt of the conditioning code and relay station code. The message is reproduced in the form of perforated tape by the reperforator portion of the reperforator-transmitter distributor. At the same instant,

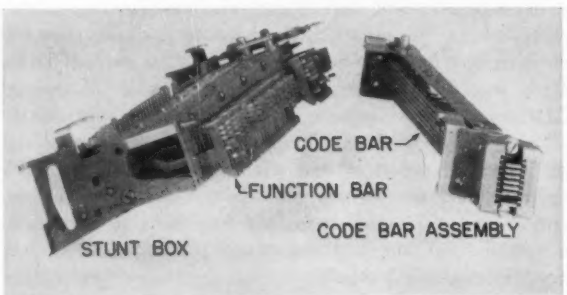

Fig. 4. Stunt-box and code-bar assembly, showing relationship of function and code bars

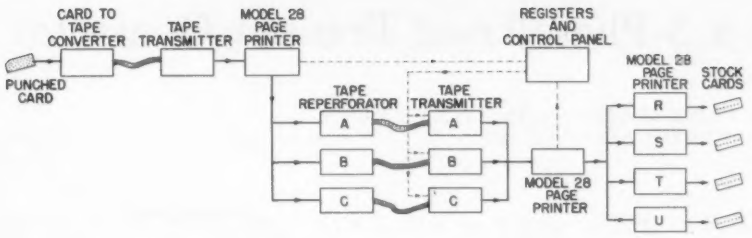

Fig. 5. Integrated data-processing system, utilizing Model 28 equipment

the circuit in the adjacent area is sampled to determine if it is busy. If the circuit is available, the tape is read by the transmitting portion of the reperforator-transmitter distributor and retransmitted. If the circuit is busy, the message is stored in the perforated tape for retransmission when the circuit becomes available.

The typing units used in this network contain many additional features including: (1) ability to respond to both individual and area station codes; (2) control of auxiliary apparatus; (3) suppression of line feed and signal bell operation when the unit is in the nonprint condition; (4) operation of the line feed mechanism of selected units on receipt of the conditioning code; (5) local operation of the blocking mechanism for line monitoring; and (6) the ability of associated transmitter–distributor to shift the typing unit to the print condition without transmitting the conditioning or station codes.

INTEGRATED DATA PROCESSING

INTEGRATED DATA PROCESSING, as the name implies, is the integration of data processes to achieve an automatic flow of information from one data processing machine to another. Mechanical and electronic data-processing devices of many types are available to perform the tedious tasks that are a part of office routines. Integration of this data-processing equipment may be simplified by the use of the Teletype Model *28* page printer set in combination with perforated tape handling equipment. This simplification is possible because of the ability of the typing unit to perform many switching, sorting, and checking functions, in addition to recording desired data.

An explanation of an order-handling system providing rapid service on parts orders will illustrate the potential use of Model *28* equipment in this field. This system accepts random orders for separation in accordance with priority levels, and then directs the items of each order to the proper stock area.

The input to the system, as illustrated in Fig. 5, is a punched card, prepared by a key-punch operator, for each item on the order. The cards contain the necessary parts ordering information and the required directing codes, which indicate the priority of the order and the item stock location.

The punched cards are placed into a card-to-tape converter, which prepares a continuous common-language 5-unit Baudot-code perforated tape. In addition to converting the information from card to tape, the converter inserts additional codes which are required for conditioning and releasing the switching equipment.

The prepared tape is placed into a transmitter of the type used for normal telegraph transmission. The information contained in the tape is transmitted to a Model *28* page printer set. The order directing codes are "read" by the typing-unit stunt-box mechanism which connects the desired tape reperforator to the transmitter. As a result, one tape containing a random sequence of orders is separated into three tapes, each of which contains orders of a given priority level. The separation is accomplished by using the stunt box of the Model *28* typing unit without the aid of any auxiliary relay or electronic equipment.

In addition to performing switching functions, the typing unit is available for recording the transmitted information. An invoice, shipping paper, or inventory record may, therefore, be prepared at the same instant and by the machine performing the circuit switching functions. Registers on a control panel are operated by contacts on the stunt box to provide a visible indication of the number of items, according to priority level and stock location, to be dispersed to stock areas.

The tapes prepared by the three reperforators *A*, *B*, and *C* are placed into their respective transmitters *A*, *B*, and *C* for transmission to the desired stock areas; the three tape transmitters operate one at a time under the control of a dispatcher. The stock area directing codes are "read" by a second Model *28* typing unit which connects the desired stock area typing unit to the transmitter then operating. The stock area printer sets produce a stock ticket containing, in printed form, the same ordering information that appeared in the original punched cards. The typing unit, performing this sorting operation operates registers to record the number and priority level of items dispersed to the stock areas.

The registers, operated by the two typing units performing the switching, provide the dispatcher with the load on each stock area, both in the number of items waiting for distribution and the number of items dispersed. Utilizing this information, the dispatcher is able to move the high-priority orders first, but without overloading any particular stock area.

CONCLUSION

The experience gained in developing equipment for the systems described, together with the proved versatility and reliability of the stunt box, is expected to lead to an expanded use of the Teletype Model *28* page printer set in selective calling, integrated data processing, and automation.

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Sensing Methods for a 3-Phase Load Transfer Contactor

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P. L. EPSTEIN

A LOAD TRANSFER CONTACTOR is a device which connects a bank of loads to one of two power sources, herein called the normal and alternate power sources. Self-contained load transfer contactors presently employed in aircraft contain three sensing relays, each relay being connected line-to-neutral, to detect failure of the normal power source. This arrangement has the disadvantages that line-to-line faults on the normal power source may not be detected, required close tolerances on pickup and dropout voltage are difficult to maintain in an aircraft environment, and loads may be unnecessarily transferred to an alternate power source.

Improved performance may be attained by applying two concepts of sensing which are new to the aircraft industry:

1. Comparing the normal power source voltage to the alternate power source voltage, rather than to an arbitrary reference voltage.
2. Sensing the positive- and negative-sequence components of the 3-phase voltages, rather than individual phase voltages.

Positive-sequence voltage is an indication of voltage level, and may be the basis for detection of a balanced fault. Negative-sequence voltage is an indication of voltage unbalance, and may be the basis for detection of either a line-to-neutral or line-to-line fault.

The application of these concepts led to the load transfer contactor illustrated by the simplified block diagram in Fig. 1. As shown, both the positive- and negative-sequence components of the two input voltages are sensed, rectified, and applied to a 4-coil single-throw polarized relay. The connections to the coils are such that the positive-sequence component of the normal power source voltage tends to prevent relay operation, while the negative-sequence component of the normal power source voltage tends to cause relay operation. The effects of the sequence components of the alternate power source voltage are just the opposite, so that the polarized relay normally has no net signal. However, any fault or failure of the normal power source, without a simultaneous failure of the alternate power source, disrupts the balance of the polarized relay, thus actuating the time delay relay and, in turn, actuating the main contacts.

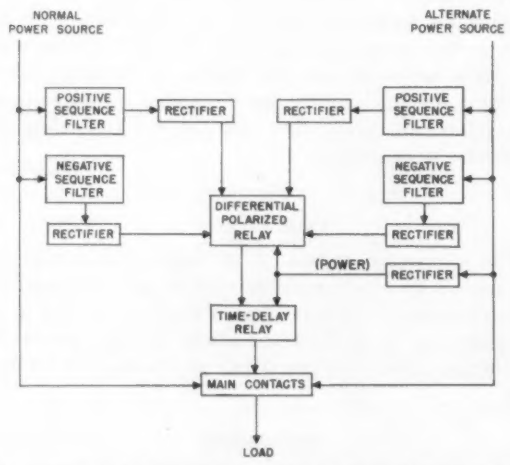

Fig. 1. Block diagram of a new load transfer contactor

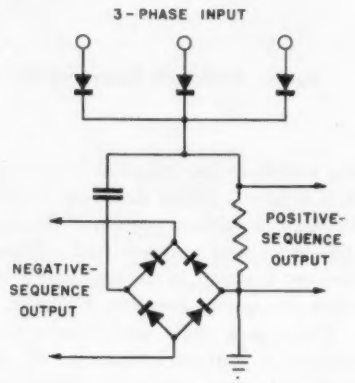

Fig. 2. Details of sensing circuit

In developing this new contactor, it was found that conventional sequence filters were not suitable for the relatively wide variations in frequency and temperature encountered in aircraft. Consequently, the sensing circuit illustrated in Fig. 2 was conceived. This circuit approximates positive-sequence voltage by the average output of a 3-phase rectifier, and approximates negative-sequence voltage by the magnitude of the ripple in the rectifier output. The circuit in Fig. 2 is completely insensitive to frequency and can be easily compensated for temperature changes. Further improvement was attained by using a saturable reactor both to perform the functions of the differential polarized relay and to provide the necessary time delay, thus making the sensing circuit static except for one conventional pilot relay.

Compared to older types of load transfer contactors, the new contactor, as finally developed, has the advantages of reduced size and weight, proper response to all types of faults, and reduced sensitivity to vibration, temperature, and frequency changes.

Digest of paper **55-827**, "Sensing Methods Applicable to a 3-Phase Load Transfer Contactor," recommended by the AIEE Committee on Air Transportation and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Conference on Aircraft Electrical Applications, Los Angeles, Calif., October 25-27, 1955. Published in AIEE *Applications and Industry*, January 1956, pp. 471-9.

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The use of ripple voltage sensing as a substitute for a conventional negative-sequence filter was suggested by **R. L. Arntz** of the Hartman Electrical Manufacturing Company.

Hunting of a Salient-Pole Synchronous Machine

C. CONCORDIA
FELLOW AIEE

FORMULAS HAVE BEEN AVAILABLE for a long time for damping and synchronizing torque coefficients of a synchronous machine hunting while in normal synchronous operation. These formulas have been used in many studies of hunting phenomena, and numerical values of the coefficients for a range of synchronous-generator parameters have been reported previously.

In addition, formulas have been given for the damping and synchronizing torque coefficients of an induction motor hunting about some steady-state operating slip. (These formulas also covered the case of a symmetric-rotor power selsyn.) Values of these coefficients have also been published for a range of induction-motor circuit parameters.

Thus, the effects of rotor saliency and of slip have been considered separately in previous papers. Here the theory is extended to include both effects simultaneously.

Most synchronous motors are started and brought up to near synchronism as induction motors. During this starting period they may be subject to hunting, and it may, therefore, be desirable to know the damping and synchronizing torque of a synchronous motor operating as an induction motor. The formulas given do not cover this case.

A synchronous motor has, in general, a salient-pole rotor; that is, its rotor has electric and magnetic characteristics which vary depending on the axis along which it is viewed, and has only two axes of symmetry, the pole (or direct) axis and the interpole (or quadrature) axis. This lack of uniformity of the rotor causes a continual pulsation of the armature currents at twice slip frequency and a corresponding torque pulsation of twice slip frequency, even with a constant slip. This pulsating torque itself tends to produce oscillations of slip at twice slip frequency. On this basis alone, one would suppose that it was important to determine the torque characteristics as affected by the hunting so produced. However, the starting period is essentially a transient condition; that is, the machine does not remain at one particular slip, but instead accelerates continually from standstill to the pull-in slip, and is then synchronized. Thus, any possible resonance conditions are usually passed through relatively quickly, and hunting is not important. However, a few cases have occurred in which the connected inertia is extremely high and in which, therefore, the starting time is rather long. In these cases, it becomes desirable to consider the possibility of high shaft torques which might be produced by the inherent torque pulsation and which will be affected by the damping torque of the machine.

Formulas are presented here which may be used to calculate damping and synchronizing torque coefficients of salient-pole synchronous motors during the starting period, i.e., when they are hunting about some steady-state slip. The formulas are valid for any hunting frequency, but are restricted to the case where the machine field circuit is unexcited and the armature resistance is small.

The same nonuniformity of the rotor that produces a torque pulsation at twice slip frequency for constant-slip operation also complicates the problem of calculating the hunting torque for small oscillations about the average slip. In deriving equations for torque caused by small oscillations, it is convenient to be able to distinguish easily those components of flux linkage and current which contribute directly to this torque. This is done most easily by choosing reference axes along which all the steady-state quantities are constants. In the present case there are no such axes. However, if the assumption is made that the machine armature resistance is zero, axes can be found along which the armature flux linkages remain simply constants even when the machine speed varies, despite the fact that the currents may vary even in the steady state. The torques become simply proportional to the currents, and it becomes easy to calculate and to identify all of the components of torque that depend on the oscillation. In particular, it becomes easy to be sure that we have accounted for all of the components of torque contributing to damping and spring action of the oscillation; that is, that we have accounted for all the components of torque that are of the same frequency as, and are proportional to, the oscillation.

In the case of hunting with a sinusoidal (or equivalent exponential) variation of speed, at per unit frequency h, the resulting change in torque has the equation:

$$\Delta T(jh) = [y_S[j(h+s)] + y_S[j(h-s)] - \epsilon^{2jst} y_D [j(h+s)] - \epsilon^{-2jst} y_D[j(h-s)] - y_S (js) - y_S(-js) - \epsilon^{2jst} y_D(js) - \epsilon^{-2jst} y_D(-js)] \frac{\epsilon^2}{2} A \epsilon^{jht}$$

On the basis of this study, the following conclusions were reached:

1. The variations of torque caused by hunting of an unexcited salient-pole electrical machine in asynchronous operation and when the armature resistance is small, may be expressed by formulas.
2. Hunting at twice slip frequency can produce a change in the average torque.
3. The development is of theoretical interest as it applies several concepts which should be useful in other instances as well. These concepts are: (a) freely rotating reference axes, (b) operational admittances, and (c) exponential form of the transformation equations.
4. It may be desirable to explore the magnitude of the change in average torque for some typical synchronous motors.

Digest of paper 56-1, "Hunting of a Salient-Pole Synchronous Machine During Starting," recommended by the AIEE Committee on Rotating Machinery and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 30–February 3, 1956. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1956.

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Air-Turbine Drives

Performance and Limitations

L. ROYCE

This article discusses the imposed requirements at the design point, or when receiving a minimum of high-pressure air supply from the compressor, and the penalty involved at the cruise condition. Turbine configurations and control-system response rates are compared.

THE PRACTICE in modern jet aircraft of using axial flow jet-engine compressors has decreased the number of engine pads available for driving accessories. This fact, coupled with the presence of a high-pressure air supply as a source of power, has brought about the introduction of the air turbine as a prime mover. Since the energy level of the jet-engine bleed air is dependent upon the engine setting, which in turn is dependent upon the airplane flight condition, the design of the turbine drive will be dictated, mainly, by the flight condition which gives a minimum energy supply to the prime mover and, also, by the power that must be developed by the prime mover. These factors will influence the performance of the unit at the airplane cruise condition where air consumption is most critical. The first section of this article will thus concern itself with the imposed requirements at the design point and the penalty involved, performancewise, at the cruise condition. Subsequent sections will deal with the turbine configuration and the turbine control-system response rate.

THERMODYNAMIC PERFORMANCE

THE HORSEPOWER that is developed by a turbine is proportional to the product of the temperature drop of the air passing through the turbine and the turbine air-flow rate. Turbine temperature drop is used in place of enthalpy drop since the specific heat of air is assumed constant. The turbine air temperature drop depends upon the pressure and temperature of the air supplied to the unit at a given altitude and the turbine efficiency. The weight flow through the unit is dependent upon the pressure and temperature of the air supplied to the unit and the turbine nozzle area.

Figs. 1 and 2 represent a typical set of bleed pressures and temperatures available from the jet-engine compressor for the idle let-down and cruise flight conditions. Using these values and assuming that turbine efficiency is 100 per cent, the maximum possible temperature drop through the turbine can be found in Fig. 3. The curves show that the turbine air temperature drop increases with altitude and the cruise temperature drop is the larger at any given altitude. Referring to Figs. 1 and 2 again, and using a nozzle area of 1 square inch, the weight flow per square inch of nozzle area for each flight condition can be calculated; the results are plotted in Fig. 4. The curves show that weight flow decreases with increasing altitude and at a given altitude is smaller for the idle let-down condition. Combining the information of Figs. 3 and 4 results in the horsepower that the unit can develop when the turbine efficiency is 100 per cent and the nozzle area is 1 square inch. Fig. 5 shows that the capacity of the turbine is always greater at cruise than at idle let-down and that the 10,000-foot idle let-down condition is the most critical operating point of the turbine. The horsepower developed at any operating point can be changed by selecting a new nozzle area; the new horsepower value being equal to the horsepower from Fig. 5 multiplied by the new nozzle area. Thus, it can be seen that for any given nozzle area, operation at 10,000 feet idle let-down will always result in the smallest horsepower. Therefore, for the assumed bleed conditions, 10,000 feet idle let-down is the design point for the turbine.

Fig. 5 shows that if the turbine is sized to produce a given horsepower at the design point, then at all other operating conditions this same turbine will be capable of developing a greater horsepower. If it is desired to run the unit at constant load at various operating conditions, some method must be employed to limit the turbine power. Inasmuch as horsepower is dependent upon turbine air temperature drop and weight flow, a control of either of these values will result in constant turbine power. Since turbine air temperature drop depends upon turbine supply pressure, the turbine air temperature drop can be decreased at any operating point by reducing the bleed air pressure at the inlet to the unit. This type of control is a throttling control using a constant or fixed turbine nozzle area. Control of turbine horsepower can also be accomplished by regulating the weight flow through the turbine. Since the weight flow is directly proportional to the turbine nozzle area, the nozzle area can be varied to change the turbine horsepower. This configuration is called a variable-area turbine.

FIXED- AND VARIABLE-AREA TURBINES

THE PERFORMANCE of a fixed- and a variable-area turbine is almost identical at the design point. At this operating point the supply conditions are the same for both units and, so, for a given turbine horsepower, both units will have approximately the same nozzle area and, thus, the same air

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consumption. If the operation of the two units at an off design point is considered, it can be seen that the variable-area unit will require a nozzel-area decrease to maintain the same horsepower, while the fixed-area unit will require throttling. Throttling reduces the available energy supplied to the unit per pound of air and, thus, the fixed-area unit will require a larger number of pounds of air to produce the required horsepower at the off design point than the variable-area unit, which is working with the higher energy air supply.

If it is assumed that the turbine drives an alternator rated at 12 kva, and if the power factor is 0.9, the alternator efficiency is 0.8, and the turbine gear-box efficiency is 0.95, then rated turbine load is 19.1 hp. If the unit is designed so that the maximum power output at 10,000 feet idle let-down is 19.1 hp, then with 100-per-cent turbine efficiency the turbine required nozzle area would be 0.667 square inch. For a design-point maximum load of 125 per cent rated (23.9 turbine hp), the required nozzle area would be 0.835 square inch. Table I lists the nozzle-area requirements for the 10,000-foot idle let-down design point for various load requirements.

The off design point of major importance is the point at which the most extended period of operation occurs. If

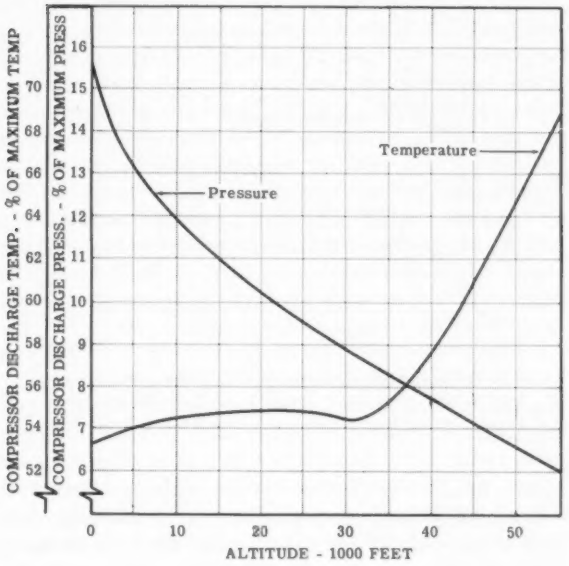
COMPRESSOR DISCHARGE TEMP. - % OF MAXIMUM TEMP
COMPRESSOR DISCHARGE PRESS. - % OF MAXIMUM PRESS
Temperature
Pressure
ALTITUDE - 1000 FEET

Fig. 1. Bleed pressure and temperature vs altitude-idle let down

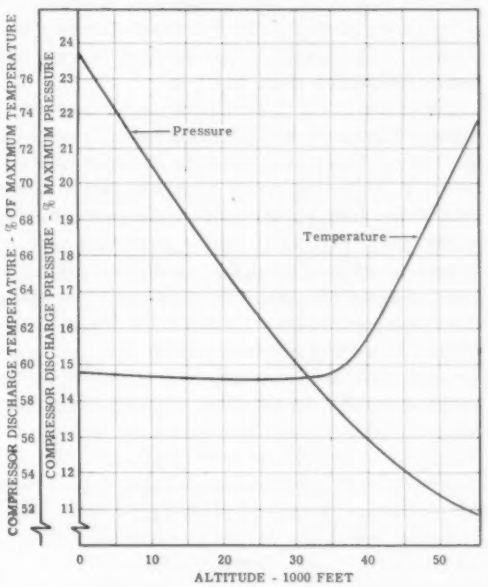
COMPRESSOR DISCHARGE TEMPERATURE - % OF MAXIMUM TEMPERATURE
COMPRESSOR DISCHARGE PRESSURE - % MAXIMUM PRESSURE
Pressure
Temperature
ALTITUDE - 1000 FEET

Fig. 2. Bleed pressure and temperature vs altitude-cruise

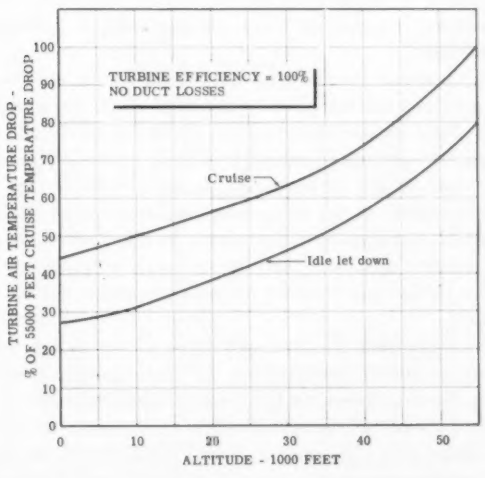
TURBINE AIR TEMPERATURE DROP - % OF 55000 FEET CRUISE TEMPERATURE DROP
TURBINE EFFICIENCY = 100%
NO DUCT LOSSES
Cruise
Idle let down
ALTITUDE - 1000 FEET

Fig. 3. Turbine air temperature drop vs altitude

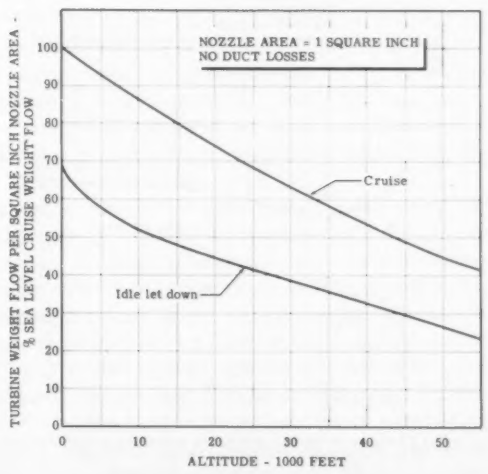
TURBINE WEIGHT FLOW PER SQUARE INCH NOZZLE AREA - % SEA LEVEL CRUISE WEIGHT FLOW
NOZZLE AREA = 1 SQUARE INCH
NO DUCT LOSSES
Cruise
Idle let down
ALTITUDE - 1000 FEET

Fig. 4. Turbine wing flow vs altitude

Table I. 10,000 Feet Idle Let-Down, 100-Per-Cent Turbine Efficiency

Load Requirement, Per Cent of Rated	Turbine Required Hp	Nozzle-Area Required, Square Inches
100	19.1	0.667
125	23.9	0.835
150	28.6	1.0
175	33.4	1.17
200	38.2	1.335

this point should be fixed at 40,000 feet cruise with the turbine operating at 100-per-cent rated load (19.1 hp), and if it is assumed that the turbine efficiency is 100 per cent at 40,000 feet cruise, the required air-flow rate to carry 100-per-cent load for a fixed nozzle-area design can be calculated by using each of the five design nozzle areas listed in Table I. The results of this calculation are shown by the higher weight flow curve in Fig. 6.

Inspection of Fig. 6 shows that, as the load at the design point is increased, the air consumption required to enable the turbine to develop the same horsepower (100 per cent rated) at 40,000 feet cruise increases. Since increasing the load at the design point increases the power capacity at the cruise point (Fig. 5), it can be seen that each additional increase in load at the design point results in an additional increase in the amount of throttling required at the 40,000-foot cruise point to keep a constant load (100 per cent rated). Hence, the turbine operates with air at a lower energy level for each increase in throttling and, therefore, the turbine requires a greater weight flow to develop the same horsepower.

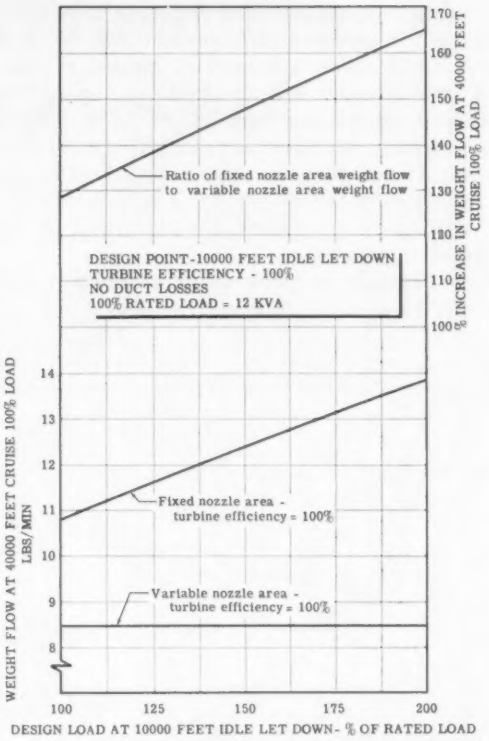
Ratio of fixed nozzle area weight flow to variable nozzle area weight flow
DESIGN POINT-10000 FEET IDLE LET DOWN
TURBINE EFFICIENCY - 100%
NO DUCT LOSSES
100% RATED LOAD = 12 KVA
Fixed nozzle area - turbine efficiency = 100%
Variable nozzle area - turbine efficiency = 100%
WEIGHT FLOW AT 40000 FEET CRUISE 100% LOAD LBS/MIN
% INCREASE IN WEIGHT FLOW AT 40000 FEET CRUISE 100% LOAD
DESIGN LOAD AT 10000 FEET IDLE LET DOWN- % OF RATED LOAD

Fig. 6. Weight flow at 40,000 feet cruise, 100-per-cent load vs per cent rated design load; ratio of fixed-area to variable-area weight flow vs per cent rated design load

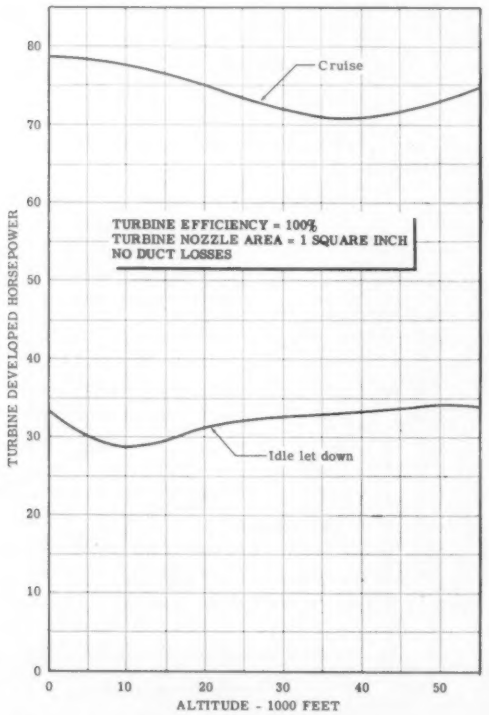

Fig. 5. Turbine-developed horsepower vs altitude

For the five design points listed in Table I, a variable-area turbine operating at 40,000 feet cruise, 100-per-cent rated load, and 100-per-cent turbine efficiency would require the air consumption shown by the lower weight-flow curve of Fig. 6. The curves show that the air consumption for 100-per-cent load and 100-per-cent turbine efficiency at 40,000 feet cruise is independent of the load at the design point. This is true because no throttling is present in a variable-area design.

Fig. 6 shows the variation with load at the 10,000-foot idle let-down design point of the ratio of air consumption for a fixed nozzle-area turbine operating at 40,000 feet cruise, 100-per-cent turbine efficiency, and 100-per-cent rated load to the air consumption for a variable-area turbine operating at the same condition and same efficiency. These comparisons have been made on the basis of 100-per-cent turbine efficiency, and by assuming no pressure drop caused by ducting between the jet compressor and the turbine.

Using the duct characteristic curve shown in Fig. 7 and actual turbine efficiencies for fixed- and variable-area turbines, the data shown on Fig. 6 can be recalculated.

Fig. 8 is a plot of the actual weight flow required at 40,000 feet cruise and 100-per-cent rated load for both the fixed- and variable-area designs vs load at 10,000 feet idle let-down and the ratio of the actual weight flows for the two types of turbines.

Three interesting observations can be made from Figs. 6 and 8. First, the air consumption for both types of turbines is greater when duct losses and actual turbine efficiencies are taken into account; second, the actual air consumption for the variable-area design increases with increases in the load at the 10,000-foot idle let-down point; and, third, the per-cent increase in required weight flow for the fixed-area design compared to the variable-area design is smaller in the actual case than in the ideal case of no duct losses and 100-per-cent turbine efficiency.

The first observation listed is almost self-evident. When actual losses are taken into account, the air consumption required increases.

The fact that the actual air consumption of the variable-area turbine increases at 40,000 feet cruise and 100-per-cent rated load with increasing load at the 10,000-foot idle let-down point (ideal air flow was shown to be independent of design-point load) is because of the turbine-efficiency variation with nozzle area. As the load at the design point is increased, the variable-area maximum nozzle area increases, and so the nozzle-area variation from the design-point nozzle area to the 40,000 feet cruise and 100-per-cent-load nozzle area increases, and turbine efficiency falls.

The third observation is the most important; it shows that the penalty of using a fixed-area design rather than a variable-area design does not result in as large a percentage increase in air consumption as would be indicated theoretically.

Fig. 8, based on typical bleed conditions and typical duct and turbine characteristics, shows the penalty one must pay in air consumption at the cruise condition for increasing the load requirement at the design point. The curves show that regardless of the type of turbine selected, the weight flow will increase as turbine design load increases. By doubling the design load, the fixed-area unit operating at 100-per-cent load at 40,000 feet cruise will increase its air consumption by 36 per cent while the variable-area unit will increase its air consumption by 19 per cent. It becomes imperative, then, to evaluate thoroughly the actual electric loads at the design point to establish a realistic design load for the turbine. It should be remembered that the turbine will be capable of developing a greater horsepower than the design horsepower at all operating conditions other than the design point.

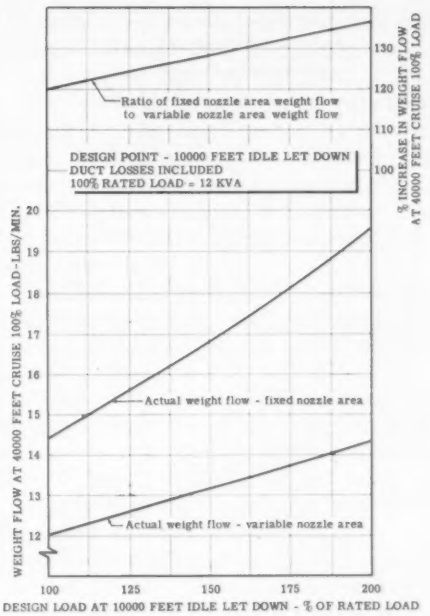
Ratio of fixed nozzle area weight flow to variable nozzle area weight flow
DESIGN POINT - 10000 FEET IDLE LET DOWN
DUCT LOSSES INCLUDED
100% RATED LOAD = 12 KVA
Actual weight flow - fixed nozzle area
Actual weight flow - variable nozzle area
WEIGHT FLOW AT 40000 FEET CRUISE 100% LOAD-LBS/MIN.
% INCREASE IN WEIGHT FLOW AT 40000 FEET CRUISE 100% LOAD
DESIGN LOAD AT 10000 FEET IDLE LET DOWN - % OF RATED LOAD

Fig. 8. Actual weight flow at 40,000 feet cruise, 100-per-cent load vs rated design load; ratio of fixed area to variable area weight flow vs per cent rated design load

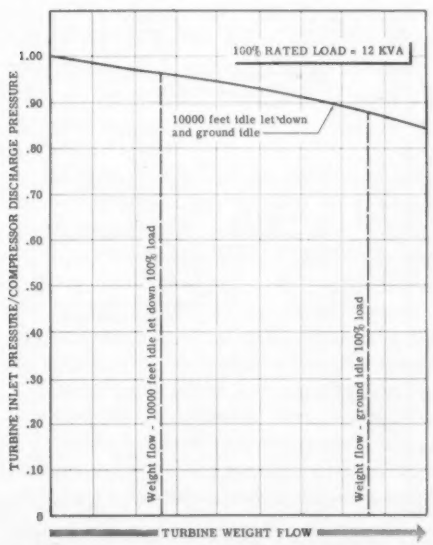
100% RATED LOAD = 12 KVA
10000 feet idle let down and ground idle
Weight flow - 10000 feet idle let down 100% load
Weight flow - ground idle 100% load
TURBINE INLET PRESSURE/COMPRESSOR DISCHARGE PRESSURE
TURBINE WEIGHT FLOW

Fig. 7. Turbine pressure over compressor discharge pressure vs turbine weight flow

GROUND-IDLE CONDITION

THIS ANALYSIS was carried out using bleed data during flight. There are cases where the turbine is required to operate during a ground-idle condition. If this is the case, then the design point for the turbine becomes ground idle. The ground-idle design point is usually so much more critical to unit performance at the cruise condition that a short discussion is warranted to stress the importance of the load requirement at the design point.

Let us assume that the jet-engine compressor ground-idle pressure ratio is 1.6, making the bleed pressure 47.8 inches Hg. Further, by using the same duct characteristic as was used for the 10,000-foot idle let-down design point (Fig. 7), the horsepower output of the turbine for the ground-idle condition can be plotted as a function of the turbine nozzle area. Fig. 9 shows that for the bleed pressure of 47.8 inches Hg and the assumed duct losses, the actual turbine horsepower and the turbine horsepower based on 100-per-cent turbine efficiency both increase as larger values of nozzle area are selected, up to a certain value of nozzle area. Selecting still larger nozzle areas results in a de-

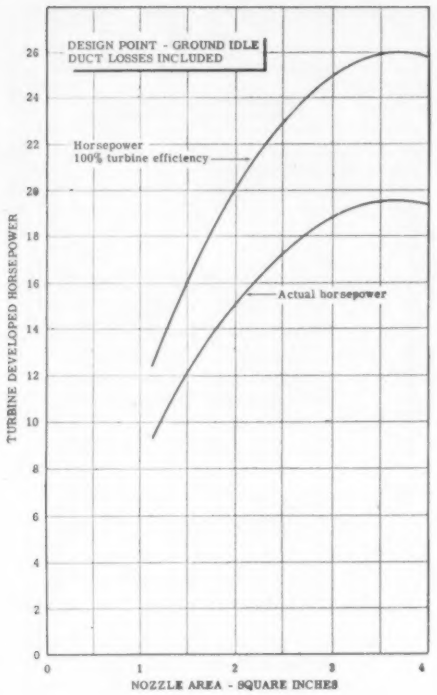

Fig. 9. Turbine design horsepower vs nozzle area

crease in turbine power, rather than an increase. This is a very important characteristic because it shows that if the duct is too small, the duct actually limits the amount of power that the turbine can develop. Fig. 9 shows that 100-per-cent rated power (19.1 hp) can be obtained at ground idle, but 125 per cent is not possible with the assumed duct. For the 100-per-cent load at ground idle as design point, the actual air consumption at 40,000 feet cruise and 100-per-cent load for a fixed-area turbine would be 24.7 pounds per minute. This represents an increase of 72 per cent over the weight flow at 40,000 feet cruise and 100-per-cent load for a fixed-area turbine based on a 100-per-cent load at the 10,000-foot idle let-down design point. The 24.7-pounds-per-minute air consumption is plotted on Fig. 10.

The limitation in the turbine power at the ground-idle design point is only caused by the duct loss. Evidently, the duct size can be increased, up to a point, to get whatever power is desired. However, the large increase in required weight flow at cruise is not caused entirely by the duct loss. This is shown by assuming no duct loss and using actual turbine efficiencies to calculate the 40,000-foot cruise fixed-nozzle area and 100-per-cent load weight flows. These data are plotted in Fig. 10 and by comparison with Fig. 8 show increases in actual weight flow of approximately 39 per cent over the weight flow at 40,000-foot cruise fixed nozzle-area and 100-per-cent load, when the design point was 10,000 feet idle let-down and duct losses were included. The introduction of the ground-idle point as the design point of the unit works a hardship on the variable-area design, as well as the fixed-area design. Since the maximum nozzle-area requirement increases in going from 10,000 feet idle let-down to the ground-idle design point, the area ratio range through which the nozzles must be varied is increased. There is a mechanical limitation to this variation and if the limit is exceeded then throttling must be employed. Therefore, without going into details of variable-area performance at cruise based on ground-idle design, it is sufficient to say that the air consumption will be considerably in excess of the values shown on Fig. 8 for the 10,000-foot idle let-down design point.

The discussion has been confined to the performance of fixed- and variable-nozzle-area turbines. In particular applications, it may be advantageous to use designs involving partial admission, multiwheels, or variable turbine speed, in conjunction with constant output speed. The partial admission arrangement is really a modified variable-area design, where the nozzle area is increased in large steps rather than continuously. Multiwheel configurations are useful when the required operating range calls for two entirely different nozzle areas and the losses involved in a partial-admission design are objectionable. Variable-turbine-speed units are helpful in enabling a better matching of the turbine characteristic to the bleed air pressure schedule. The thermodynamic performance of all of these turbines falls between the performance of the fixed- and variable-area designs and is adversely affected by increased load requirments at the design point.

Regardless of the type of unit used, the selection of the minimum acceptable load at the minimum jet bleed air energy point will afford considerable savings in unit air consumption at all operating points and particularly at cruise and, in cases where duct sizes are limited by the unit location, will allow a practical solution to a design of an alternator drive. If the turbine cannot develop the required power when load requirements are held to a minimum and duct size is a maximum, the last resort is to in-

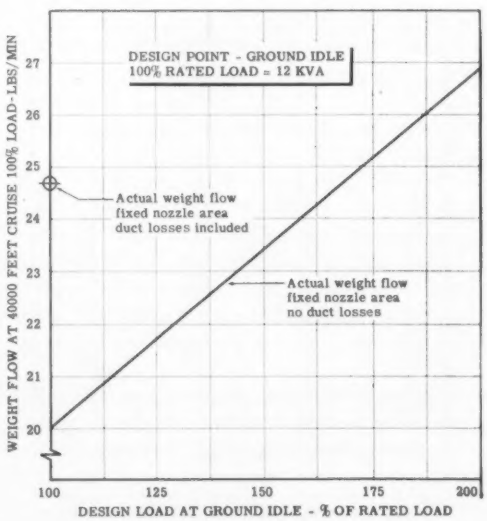

Fig. 10. Actual weight flow at 40,000 feet cruise, 100-per-cent load vs rated design load

crease the idle speed of the engine to obtain the required turbine power.

TURBINE CONFIGURATION

In general, there are any number of possible turbine configurations that can be used to develop power. The following discussion deals only with those turbines that experience has shown to be most adaptable to aircraft use.

The two basic types of turbines can be broken down into classification based upon direction of flow of the air through the turbine, as follows:

1. Fixed area: Axial flow and centripetal flow
2. Variable area: Centripetal flow

The general physical dimensions of an axial turbine are small outside diameter and long length. The centripetal turbine is usually large in outside diameter and short in the length dimension.

Comparing the weight and volume of a fixed-area turbine to a variable-area turbine, it is found that the fixed-area unit is smaller and lighter than the variable-area unit. Also, the fixed-area turbine is much simpler mechanically.

The selection of the type of turbine to be used in a given application depends upon the load requirement, allowable unit weight and volume, and reliability required.

In deciding whether fixed area or variable area should be used, the first consideration is the space and weight limitations. In many cases, there is no choice since a variable-area unit would not fit within the allowable envelope. However, if a choice exists, then the next consideration is the magnitude of the load. If loads are small, then, although the fixed-area unit may require an appreciable percentage increase in air consumption over a variable-area design, this appreciable percentage may be a relatively small amount of air flow in terms of pounds per minute. If this is the case, it would not seem desirable to increase the weight and complexity of the turbine to save a small amount of air flow. (Unit weight decreases airplane range just as turbine air consumption does, but to a smaller degree.) If, on the other hand, the load requirements are large, it may be desirable to use variable area with its associated complexity and larger weight in order to take advantage of large-weight flow savings.

In alternator-drive applications, failure of the speed-control system to hold speed as designed is as bad, performancewise, as a complete loss of the unit. The variable-area unit, with each nozzle blade pivotable, is susceptible to much more mechanical difficulty than a fixed-nozzle design and, thus, susceptible to more speed control failures. This is an important characteristic of the variable-area unit and must be given due consideration when selecting the type of turbine to be used in a given application.

The turbine-drive configuration that is used in any particular installation is usually a unit compromised with respect to the many controlling requirements. Over-all, airplane rather than unit performance is the governing criteria.

TURBINE SPEED-CONTROL RESPONSE RATE

The nature of the electric loads found in today's airplanes requires that the speed of the alternator be held within relatively close limits during steady-state and transient operation. The means by which the speed-control requirements may be met are numerous. Electric, hydraulic, and pneumatic systems or any combination of these are possible. The response rate of a given system will depend upon the design of the system. As an example of the state of the art at this time, the response of the Stratos pneumatic speed-control system is presented. This control system is isochronous and is used in conjunction with a fixed-nozzle-area turbine.

Steady-State Reponse. The speed-control functions as an isochronous controller within ± 0.50 per cent of steady-state speed. Setting of the speed control is held to within ± 1.5 per cent of rated speed.

Transient Response. When step-load increments of ± 50-per-cent rated load are added or removed from the load, the speed recovers to 2.5 per cent of the initial steady-state speed within 0.6 second and to 1.5 per cent within 1 second. Under this condition the maximum deviation from the steady-state speed is not more than 4.5 per cent.

The ability of the unit to return rapidly to a steady-state speed after the system is disturbed by load changes is an important consideration. It is customary to specify the speed error, after a given interval of time from the initiation of the disturbance, in the form of a percentage speed variation. However, it is important to refer this percentage to the proper speed. For proportional-type governing systems, the percentage speed variation after a given time interval is usually referred to the new steady-state speed. For an isochronous control system the steady-state speed is independent of the load. Therefore, to put the two types of control systems on a comparable basis all percentages should be referred to the steady-state speed before the load change.

The response rate of a speed-control system used with a variable-area turbine will be poorer than the response rate of the system when used with a fixed-nozzle design. This is true because the inertia forces involved in positioning the variable nozzles are greater than those for positioning the throttle valve. The response of the variable-area unit may be made faster by inserting a throttle valve upstream of the variable nozzles and positioning this valve as a function of unit speed. The variable nozzles could then be positioned as a function of flight condition and altitude. This would result in the same speed response as for the fixed-nozzle design, but the throttle valve would introduce a slight throttling loss at all operating conditions.

CONCLUSIONS

The selection of the type of turbine to be used for a given application depends upon the requirements for the particular job. In general, a variable-area turbine requires less air flow, weighs more, takes more space, and is more complicated than a fixed-area unit. The performance of either type of a unit at all operating points and, particularly, at the cruise condition of the airplane suffers as the load requirement at the unit design point is increased. Every effort should be made to evaluate the minimum acceptable load at the turbine design point, which usually occurs at the minimum energy level of the bleed air.

Problems of Revising AIEE Standard Number 1

A PROGRESS REPORT OF CO-ORDINATING COMMITTEE NUMBER 4

A revision of AIEE Standard Number 1, "General Principles upon which Temperature Limits Are Based in the Rating of Electric Machines and Other Equipment," was necessitated because of the present use of many new materials and the fact that past appraisals of materials were incomplete. A general plan for such a revision, as well as proposals for overcoming immediate difficulties in the present standard, has been formulated by the working groups of AIEE Standard Co-ordinating Committee Number 4 and are presented in this article.

FOR OVER 40 YEARS, it has been the practice in the electrical industry to establish the thermal rating of apparatus on the basis of the materials used in the insulation system of the equipment. This practice was instituted by Steinmetz and Lamme at a time when insulating material selection was limited to impregnated cellulosic materials, combinations of inorganic and organic materials, and ceramic materials.

Letter designations or classes were chosen to identify the various types of electrical insulating materials. These were the familiar Classes *A*, *B*, and *C* which are still in active use today. Later, as the need developed, two additional classifications, *O* and *H*, were added. The definitions of these five classifications describe the materials grouped under each, based primarily on the chemical composition of the materials, that is, whether they are organic or inorganic. A material is selected for a particular classification only if its chemical composition satisfies the definition for that classification.

This method of classifying insulating materials has been used over the years and gradually, because of this, the same letter classifications became associated with the apparatus in which a particular class of material was used. Thus, it has become common practice to designate a transformer or motor utilizing primarily Class *B* insulation as a Class *B* transformer or a Class *B* motor, even though nowhere in the standards are there any such designations for the thermal rating of electric machines and apparatus.

The fact that this practice has been in use over 40 years is a tribute to the pioneering efforts of Steinmetz and Lamme and, also, to the contemporary designers of electric equipment who established temperature limits on rather meager experimental data. At that time, methods now available for the evaluation of insulating materials were unknown.

An early indication that material classifications were not entirely desirable in thermally rating electric apparatus occurred 15 to 20 years ago in the design and application of Class *B* dry-type transformers. Many believed at that time that in order for equipment to be identified as Class *B*, the equipment should be insulated throughout with Class *B* insulating materials. It became necessary to distinguish between insulating materials used in the equipment at the limiting temperatures and other insulating materials used at locations where reduced temperatures existed. In the early issues of AIEE Standard Number 1, as far back as 1914, and other standards, including the 1942 edition of the American Standards Association's (ASA) Rotating Electric Machinery Standard, *ASA C50*, it was specifically recognized that materials of different classes could properly be used in a single machine as long as each material was suitable for withstanding the temperatures to which it would be exposed in service. In the 1925 revision of AIEE Standard Number 1, and in other standards, however, this provision was changed, implying that insulating materials of the highest temperature class should be used throughout a given piece of equipment.

In dry-type transformers, there is a wide spread between the highest and lowest temperatures to which different parts of the insulation system are exposed. Further, it was found that the insulating cylinder, which usually is cooler than the interior of the windings, is not as good in dielectric and mechanical qualities and, also, is much more expensive when made of Class *B* or Class *H* materials rather than of Class *A* materials. Therefore, in dry-type transformers it has become customary to make the cylinder of materials in a lower temperature class than the winding insulation. This practice has been found very satisfactory in service.

Recently, AIEE test procedures have been prepared for the thermal evaluation of new insulating materials and, also, for the evaluation of complete insulation systems. When these procedures are followed, the satisfactory performance of the entire insulation system is demonstrated by life tests, and the best material for each component can be chosen on an actual performance basis, instead of following arbitrary specifications. This is desirable, because materials with high thermal endurance may be weak mechanically or have low dielectric strength, and the different components of the insulation system may require these properties in different degrees.

Also, serious deficiencies have become apparent in the present method of classifying electrical insulation: (1)

Full text of paper CP56-247, "Problems of AIEE Standards Co-ordinating Committee Number 4 in Revising AIEE Standard Number 1," approved by the AIEE Committee on Technical Operations for presentation at the Winter General Meeting, New York, N. Y., January 30–February 3, 1956.

This report was prepared by a working group consisting of H. G. Zambell, W. W. Satterlee, and P. L. Alger.

it does not allow for the various new synthetic insulating materials which have very good thermal stability; and (2) it has been found that some combinations of materials cannot be classified properly since some materials of good thermal stability, when evaluated separately, may have relatively poor thermal stability in combination; conversely, some materials may have their thermal stability improved when used in combination with certain other materials. Furthermore, even the definitions of the higher temperature classes, such as Class *B* and Class *H*, are indefinite because they leave to the designers the choice of kind and quantity of bonding material. All these factors have confirmed the truth that insulating materials should be selected on the basis of the function they serve in a given electrical design, and not on the basis of their chemical composition alone.

In view of the expanding research and development activities associated with insulating materials, and because of the desire on the part of equipment manufacturers and users for lighter, smaller, and less expensive apparatus, a better method of insulation evaluation must be adopted as quickly as possible. Any satisfactory solution to this problem must give adequate recognition to all types of insulating materials and all types of electrical equipment. To insure complete coverage of the over-all problem, liaison with all groups associated with the individual phases of the problem must be effected. The ultimate result should appear as new co-ordinated apparatus standards established by the various groups responsible for each line of equipment. The first step toward the solution involves a complete revision of AIEE Standard Number 1. This will guide the preparation of supporting test procedures for the evaluation of insulating materials and insulation systems, and the separate standards for electric equipment.

CO-ORDINATING COMMITTEE NUMBER 4

In March 1955, Co-ordinating Committee Number 4 of the AIEE Standards Committee was reorganized. One of the principal duties of this Committee is to prepare guiding principles to be used by other AIEE committees in standards work. This involves the revision of AIEE Standard Number 1 and the co-ordination of the efforts of other AIEE committees developing test procedures for the thermal classification and evaluation of insulating materials and insulation systems for all types of electric equipment.

In order to achieve the broad coverage described in the foregoing sections, the membership of Co-ordinating Committee Number 4 includes representatives of suppliers of insulating materials, manufacturers of electric equipment, and users of this equipment. In addition, other members are included to insure liaison with all bodies engaged in the various phases of the assignment of the Committee.

The Committee has held two meetings: the first at Swampscott, Mass., on June 28, 1955, and the second at Cleveland, Ohio, on September 15 and 16, 1955. This article summarizes the discussion and action of the Committee and outlines the trends which are developing.

The important topics considered by the Committee to date can be summarized as follows: (1) the solution of "present" problems without interruption of activities aimed at establishing "future" practices; (2) clear differentiation between insulating materials and insulation systems; (3) shall emphasis in the revision of Standard Number 1 be on insulating materials or on insulation systems; (4) shall the revision of Standard Number 1 contain a tabulation of the classification of all known insulating materials; (5) shall specific test procedures for evaluating insulating materials and insulation systems be a part of the revision of Standard Number 1; (6) shall the classification nomenclature for insulating materials be contained in Standard Number 1; (7) shall the classification nomenclature for insulation systems be contained in Standard Number 1; (8) to develop guiding principles for the evaluation of insulating materials; (9) to develop guiding principles for the evaluation of insulation systems; (10) to outline a general plan for the revision of Standard Number 1; (11) to suggest ideas for the thermal rating of electric equipment; (12) to effect liaison with the American Society for Testing Materials and the International Electrotechnical Commission; (13) to deal with AIEE technical committee activities and prerogatives; and (14) to consider and deal with other related subjects. This long list of topics can be grouped into items requiring immediate and temporary revisions of Standard Number 1 to permit progress in the use of new insulating materials, and to items leading to the long-range revision of Standard Number 1, aimed at properly establishing the future evaluation and use of insulating materials and insulation systems.

IMMEDIATE AND TEMPORARY REVISIONS

The definition of Class *B* insulation in the AIEE Standard Number 1, Section 1–3, February 1954, is:

> "Class *B* insulation consists of mica, asbestos, Fiberglas, and similar inorganic materials in built-up form with organic binding substances. A small proportion of Class *A* materials may be used for structural purposes only. Fiberglas or asbestos magnet wire insulations are included in this temperature class. These may include supplementary organic materials such as polyvinyl acetal or polyamide films."

A number of new enamels have been developed which by test have been shown to withstand a temperature of 130 C, which is the hottest spot temperature for Class *B* materials. These enamels are organic in chemical structure and do not include Fiberglas or other inorganic materials. Consequently, to permit their use in commercial equipment, and still to permit them to be called Class *B* materials, some change in the above definition was required. Further, some investigators have found that certain combinations of materials containing inorganic components are unsatisfactory as Class *B* materials for some applications.

In order to take care of all such needs, the Committee decided on the following revised definitions of Class *B* and Class *H* insulations:

> "Class *B* insulation consists of materials or combinations of materials such as mica, glass fiber, asbestos, etc., with suitable bonding substances.

Other materials or combinations of materials, not necessarily inorganic, may be included in this class if by experience or accepted tests* they can be shown to be capable of operation at Class *B* temperatures."

"Class *H* insulation consists of materials or combinations of materials such as silicone elastomer, mica, glass fiber, asbestos, etc., with suitable bonding substances such as appropriate silicone resins. Other materials or combinations of materials may be included in this class if by experience or accepted tests* they can be shown to be capable of operation at Class *H* temperatures."

These suggested changes in the two definitions are of an interim nature only and are offered in order to allow progress in the use of new materials which have been shown by experience and test to be acceptable in electrical equipment, and to foster additional research and development in the field of insulating materials. Publication of these suggested changes[1] has been made for the purpose of acquainting the Institute membership with the changes and reasons for them. These definitions have been submitted to the Standards Committee for approval as an interim addendum to Standard Number 1.

Fortunately, test procedures have been published for trial use covering the evaluation of random-wound electric machinery and of enameled magnet wire. These will aid in the use of the revised definitions as presented in the foregoing sections. In the meantime, the Dielectric Committee and technical committees are preparing additional test procedures for the evaluation of other insulating materials and insulation systems. Test procedures are either published or are being prepared for the following:

Insulation Systems:

1. Random-wound electric machinery.
2. Form-wound electric machinery.
3. Ventilated dry-type power and distribution transformers.
4. Sealed dry-type power and distribution transformers.
5. Liquid-immersed distribution transformers.
6. Specialty transformers.

Insulating Materials:

1. Round enameled magnet wire.
2. Rectangular enameled magnet wire.
3. Flexible sheet insulating materials.
4. Rigid insulating materials.

THE LONG-RANGE PROGRAM

IN THE LONG-RANGE REVISION of AIEE Standard Number 1, consideration must be given to the fact that test procedures for insulating materials and insulation systems are still mostly unavailable. Hence, the old material designations and temperature limits must be retained until these procedures are developed and approved.

The Committee proposes to rearrange Standard Number 1 into four parts, to retain the present appendix essentially as it is, but with some additions or modifications, and to revise the bibliography. The four parts and suggestions for their component sections are as follows:

The first part, an introduction, will make it clear that the real purpose of Standard Number 1 is to serve as a guide for the preparation of standards for the rating of electric equipment with special reference to the selection, the measurement, and the meaning of the observable temperature rise associated with the rating. This is a main purpose of the Standard and, therefore, it will be written from the viewpoint of the design and the use of electric equipment rather than from that of insulating materials alone.

The second part will deal with the assignment and measurement of temperature limits for rating purposes, including consideration of ambient temperatures and other environmental conditions.

The third part will be devoted to consideration of insulating materials and will deal with their evaluation by approved test procedures.

The fourth part will be devoted to the evaluation of insulation systems as related to the classification of the equipment. A particular purpose for the revision of the Standard at this time is to outline guiding principles for the evaluation of insulation systems by use of approved test procedures, a new method applicable to different types of electric equipment. This functional evaluation makes unnecessary the direct association that has heretofore existed between temperature limits of particular classes of insulating materials and the rated observable temperature rise of equipment.

The four parts of the revised Standard are being undertaken by the following four working groups under the general supervision of the Committee:

1. Editorial Working Group—to rewrite the Introduction, to undertake necessary editorial work not assigned to the other working groups, and to perform the final over-all editing of the Standard. P. L. Alger, chairman.
2. Working Group on Temperature Measurement and Environmental Conditions. E. B. Paxton, chairman.
3. Working Group on the Evaluation of Insulating Materials. W. F. Dexter, chairman.
4. Working Group on the Evaluation of Insulation Systems. G. L. Moses, chairman.

New concepts will be added in the revision of the Standard carrying forward ideas already outlined in Section 1–4 of the present Standard. These will include general principles for the temperature evaluation of insulating materials together with a guide for the development of test procedures to provide a basis for this evaluation. General principles will also be included for the temperature evaluation of insulation systems together with a guide for the development of suitable system test procedures. A principal problem in this work, one which affects the material supplier, the equipment manufacturer, and the equipment user, is that of establishing a means for specifying tempera-

*"Test procedures for the evaluation of insulating materials and insulation systems are under development by the Institute. It is recommended that whenever feasible the evaluation methods in such test procedures should be followed."

ture ratings of equipment that will be compatible with the temperature characteristics of the one or more kinds of insulating materials used in a given type of equipment.

MATERIALS, SYSTEMS, AND NOMENCLATURE

In recent years numerous papers have been written stating that the life of insulating materials is a chemical rate phenomenon varying as the reciprocal of the absolute temperature. This principle has been generally accepted and makes it possible to estimate life by short-time high-temperature tests. This procedure is adaptable either to a study of insulating materials by themselves or to insulation systems, such as used in electric machinery.

Although many problems remain to be solved, it is the opinion of the Committee that the thermal classification of an insulation system, or the thermal rating of electric equipment, can be established by the testing and evaluation of a functional model, or the equipment itself, in accordance with an approved test procedure which subjects a design to specified conditions resulting in accelerated aging as compared to normal service conditions. A model, or the equipment itself, successfully meeting the life criterion of an approved test procedure should be judged of adequate design without any specific reference to the chemical nature or temperature classification of the materials comprising the insulation system.

This is a completely new concept, one which defies tradition and makes necessary a reconsideration of the nomenclature for electric equipment classification. As has been pointed out in a large number of papers comprising the current literature on this general subject, it is becoming more and more evident that equipment should be designed and evaluated functionally. Based on this premise the Committee has accepted the principle of classification by temperature rise directly without any intermediate confusing or irrelevant nomenclature, although an accompanying limit on hottest spot temperature for equipment will be definitely understood.

In establishing this new philosophy, it will be most difficult to supersede practices which have been used for decades. Certainly no one expects that the letter designations for materials will be dropped immediately or even in the near future. Neither is it reasonable to expect that the term "Class *B* transformer" will be dropped immediately and finally in favor of the term "80-C-rise transformer." However, proposals have been made to drop the letter nomenclature and to substitute "group" designations for machinery to avoid the emphasis on materials. Therefore, it seems that the way is clear to abandon the present letter classifications for either materials or systems. A further study is in progress to determine the ultimate nomenclature.

There are some who believe that system evaluation is difficult and that it would be better to continue to rate machinery thermally on the basis of the insulating materials used. It is the consensus of the Committee, however, that this is impractical because: (1) there are numerous new materials designated by trade names, and it is certainly not practical to use such descriptions of materials in Institute standards; (2) there are so many new materials, and combinations of materials, that a list of them would never be up to date; and (3) materials of the same temperature class, when used in combination or in systems, may not be compatible or suitable at a temperature as high as they will endure separately.

Some individuals desire retention of the present letter classifications for materials. It is conceded that new materials not easily classified by the present nomenclature may be classified by temperature, with no effort made to give them a letter designation. Also, new materials are apt to be found to be satisfactory at temperatures between the present classifications and cannot be labeled properly except by temperature designation unless many new letters are added. As each succeeding new material is given a temperature rating only, the letter classifications may cease to be of consequence and temperature ratings will be preferred. The trend of present thinking indicates that materials will be classified by a total temperature value directly, in accordance with test procedures for the separate kinds of materials, with the various ranges of temperatures, and the particular test models and life criteria outlined in these procedures.

In the case of systems, the trend of present thinking indicates that insulation systems and equipment should be classified by a temperature rise above a given ambient temperature, if a specified model (or the equipment itself) meets the established life criteria when subjected to the functional testing prescribed by an approved test procedure. Whereas the equipment rating will involve a temperature rise, the test procedure will prescribe the limiting hottest spot temperature which the system is expected to endure.

CLASSIFICATION AND EVALUATION OF MATERIALS

Although the final proof of the adequacy of the design of a piece of electric equipment to meet certain service requirements or specifications is in the testing or evaluation of the equipment itself, or a model of it, complete technical information on the materials composing the insulation system of the equipment must be known by the designer to insure initially a proper engineering selection of materials. In one sense, the classification and evaluation of materials constitutes an initial screening process to aid a designer in selecting those materials which have the best chance of performing satisfactorily in the final design.

In the testing of materials, a functional approach will be adopted as much as is practical. However, the final proof that a material is satisfactory functionally can only be obtained by testing the complete system of which the material is a part and then obtaining satisfactory life from the complete design in actual service.

Inasmuch as material test procedures are highly important, and comprehensive programs of material evaluation are being carried on by other societies, committees, and standardizing bodies, a guide for such evaluation is being prepared by the AIEE Co-ordinating Committee. In its final form, this guide will appear in its entirety as part three of the revision of Standard Number 1. In the preparation of the guide, the AIEE Dielectric Committee has an important role. Suggestions are welcome from all groups

in the materials testing field. Liaison with American Society of Testing Materials is also being maintained on this project. The guide is intended to serve as an outline in the preparation of material test procedures in order that these procedures will be: (1) uniform in appearance; (2) complete in individual test coverage including environmental conditions; and (3) conclusive in terms of life criteria, statistical accuracy, and method of reporting.

Although the guide will offer suggestions pertaining to the general outline and nature of these tests, it is the prerogative of the groups preparing the actual material test procedures to include whatever they deem appropriate to a complete evaluation of a given material. Working groups of the Dielectric Committee are responsible for the preparation of the individual material test procedures. Several procedures are already in preparation, as outlined earlier in this paper. This work is proceeding with the same liaison activities that exist in the preparation of the guide.

In general, the material test procedures will cover individual materials. However, the Committee has agreed that "simple combinations of materials" will be included in the general area of materials rather than systems. An example of a simple combination of materials is enameled magnet wire tested in combination with a varnish. The test procedure for enameled magnet wire now being issued for trial use outlines tests with and without varnish.

CLASSIFICATION AND EVALUATION OF SYSTEMS

THE CLASSIFICATION and evaluation of a system of insulation can be accomplished by field experience with the equipment utilizing that system. However, experience of this nature is only obtained after a considerable number of years of service operation, and even then it is difficult to establish conclusively the nature of the conditions imposed on the equipment in terms of both the loading and the environment. Nevertheless, field experience has been and will continue to be useful in establishing suitable limits of temperature for equipment even though in the case of a new design it can only substantiate at a subsequent time a temperature rating selected on the basis of the accelerated testing of full-scale equipment or models.

Whenever feasible, full-scale equipment should be utilized in system evaluation of an accelerated nature. As examples, small motors and small transformers constitute samples which are preferable to model motors or model transformers in these tests. However, since it is not at all practical to test full-scale equipment in the larger sizes, models duplicating the design of the actual equipment are used. The model approach together with the justification of the accelerated testing technique have been treated in considerable detail in the recent literature.

The preparation of a guide for the development of test procedures for systems has been assigned to a working group of the Co-ordinating Committee. In its final form this guide will appear in its entirety as Part 4 of the revision of Standard Number 1. The guide will be prepared in liaison with the various technical committees of the Institute. The guide is intended to serve as an outline in the preparation of system test procedures in order that these procedures will be: (1) uniform in appearance; (2) complete in individual test coverage, including environmental conditions; and (3) conclusive in terms of life criteria, statistical accuracy, and method of reporting.

Although the guide will offer suggestions pertaining to the general outline and nature of these tests, it is the prerogative of the groups preparing the actual system test procedures to include whatever is considered appropriate to a complete evaluation of a given system. Working groups of the various apparatus committees are responsible for the preparation of the individual system test procedures. Several procedures are already in preparation as outlined earlier in this paper.

A final nomenclature for insulation system classification has not been established as yet by the Committee. However, the trend of thinking favors rating equipment by means of a temperature rise above a given ambient when the insulation system has successfully met the requirements of an approved system test procedure. The limiting hottest-spot temperature will be included as a criterion in the test procedure but this temperature it not likely to be used in classifying a system or rating a machine, because it cannot be measured directly and because hot-spot gradients vary widely in the various types of electric equipment.

It is the opinion of the Committee that ultimately the present letter classifications for materials will not be used to classify systems or to rate machines. No reference will be made to materials in classifying systems and rating machines.

Neither is it likely that any other intermediate nomenclature such as the group designations favored at one time by the Transformer Committee and adopted by National Electrical Manufacturers Association will be encouraged by the Committee. The Committee has already gone on record as not favoring the group nomenclature. The Standards Committee has also voted down this type of classification.

In an effort to simplify the nomenclature for classifying systems and rating machines, the Committee favors the elimination of any method which does not give the essential information directly. Consequently, the trend of thinking is toward a temperature-rise designation above an ambient in accordance with an approved system test procedure.

REFERENCE

1. Insulation Classification Changes Suggested by Co-ordinating Committee. *Electrical Engineering*, vol. 74, no. 10, October 1955, pp. 934–5.

Air Balance Device "Floats" Wheels

A new machine for balancing automative wheels and tires on a film of air 0.002-inch thick has been developed by General Motors (GM) Research Staff, Oldsmobile Division. It uses a so-called air-ball pivot $1^1/_2$ inches in diameter to register automatically amount and location of unbalance.

The device was developed from an air "lubricated" bearing GM Research engineers built for a trick exhibit in the Motorama—a bearing that "floats on air with greatest ease."

Rectifier Power Supply for a Modern Rod Mill

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THE STEEL INDUSTRY in the United States is a large user of d-c electric power. Until approximately 20 years ago, the motor-generator set was used exclusively to supply the large amounts of d c power for steel-mill service. Recently, however, ignitron rectifiers have found increasingly frequent use in the making of steel. The single-line diagram of a large rod mill using ignitron rectifiers of the continuously evacuated metal-enclosed type is shown in Fig. 1. This rectifier power supply is being utilized in a large Midwestern rod mill.

The first application in the United States of the ignitron rectifiers as main-drive rod mill equipment is in a multiple-stand combination rod mill. A total of three ignitron rectifiers are utilized to furnish power to the 10 mill motors. Two of the rectifiers are rated 2,920 kw and the third is rated 3,500 kw. The d-c bus voltage is 700 volts and is continuously variable by combination transformer taps under load and phase control to 410 volts direct current.

The control and switchgear equipment does not include any bus tie switches or circuit breakers, and the three bus sections and their respective supply rectifiers will operate independently. The d-c voltage on any of the bus sections is independently variable and not dependent on the other bus sections. Fig. 2 is a front view of the metal-enclosed ignitron rectifier. The cubicle contains 12 pumped ignitron rectifier tanks, anode balance reactors, phase shifting

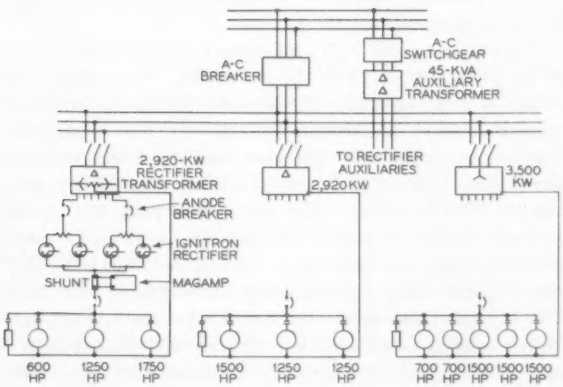

Fig. 1. Power supply for a modern rod mill

circuits and a water-to-water heat exchanger for rectifier cooling purposes. Each of the main power supply metal-enclosed ignitron rectifiers is in a factory-assembled dead-front metal-enclosed cubicle and of matching dimension and appearance with the switchgear breaker and control cubicles, which, when installed together, form a co-ordinated rectifier unit substation. The entire rectifier substation, with the exception of the transformer, is located in the motor room.

Incorporated in the over-all installation is a feature to provide operation at the maximum possible power factor. This feature is accomplished by incorporating in each rectifier power transformer a regulating auto transformer with a

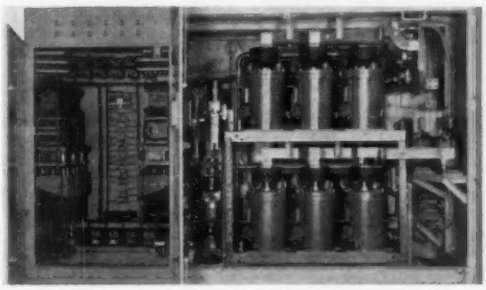

Fig. 2. Interior front view of 12-tank metal-enclosed pumped tube ignitron rectifier

load tap changer. This tap changer is under control of an automatic control relay, which receives its intelligence from the bias current in the phase-shift circuit of the excitation circuits. If the phase control current shifts above or below a preselected value, the control relay will operate, causing a tap change to provide the proper operating voltage with minimum phase retard and, thus, operating at the highest possible power factor. The lower and upper limits of the relay can be so adjusted in order to operate as near as possible to maximum power factor and, at the same time, insure a minimum number of tap-changer operations.

For a main-drive power supply, it is important that the d-c voltage be closely regulated. Each of the main-power-supply ignitron rectifiers is controlled by a magamp-type voltage regulator. The three regulators receive their intelligence from a common reference so that the whole system will respond equally to any reference voltage change. Each rectifier magamp regulator will have individual adjustment to enable operation with the same or different voltages on the three bus sections.

There are over 5-million kw of continuously evacuated ignitrons in conversion service today. With the inherent high overload capacity of the pumped tube rectifier, the low long-time maintenance, high availability for service, and high operating efficiency, the ignitron rectifier is well suited for the duty cycle imposed by steel-mill main-drive service.

Digest of paper 56-44, "Rectifier Power Supply for a Modern Rod Mill," recommended by the AIEE Committee on Industrial Power Systems and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 30–February 3, 1956. Scheduled for publication in AIEE *Applications and Industry*, 1956.

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Vacuum Switches for Power Systems

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For the first time, practical use is made of the high insulating and current interrupting ability of a high vacuum. Tests show that a vacuum switch with but 1/10-inch contact travel can clear 79-amperes at 66-kv rms has a breakdown strength of 100-kv rms.

A HIGH VACUUM possesses two outstanding properties which immediately suggest its application to equipment used in the electric-power industry. First, when used as an insulator between two conductors, a vacuum offers the highest insulating strength value known. Second, when an a-c circuit is opened by separation of contacts in a vacuum, interruption occurs at the first current zero with the dielectric strength across the contacts building up at a rate thousands of times higher than that obtained with present-day circuit breakers.

To date, no practical use has been made of these outstanding properties by switchgear manufacturers in spite of the fact that some 30 years ago, Sorensen and Mendenhall called particular attention to them in tests on experimental vacuum circuit breakers. In sharp contrast, the electronics industry through 10 years of development by Jennings Radio Manufacturing Corporation, San Jose, Calif., has been successful in the development of vacuum switches of progressively increasing voltage and current ratings. Several thousands of permanently sealed high-voltage vacuum switches have been commercially produced by the electronics industry in r-f, 60-cps, and d-c applications, functioning in some cases as a circuit closer and circuit breaker. These installations have given an outstanding service record during the past several years. Their voltage and interrupting rating is such that with slight modifications, they are ideally suited to perform specific switching duties on high-voltage a-c systems.

It is the purpose of this article to describe construction and tests of vacuum switches for power systems for voltages up to 230-kv.

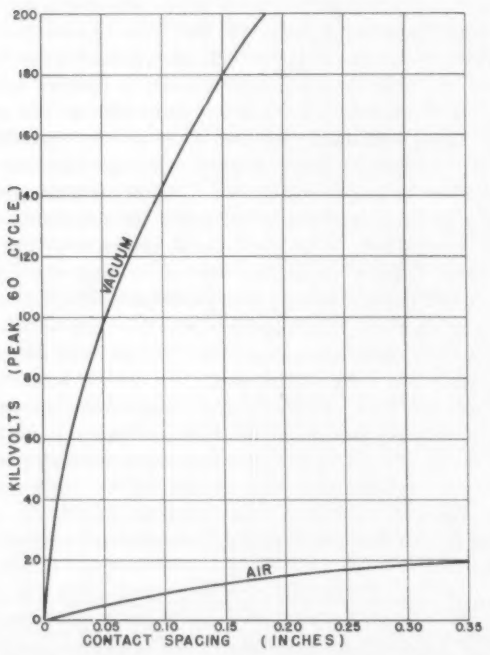

Fig. 1. Breakdown voltage of vacuum compared with air for one pair 3/8-inch-diameter tungsten contacts

PROPERTIES

Breakdown Strength of Insulation. The major insulating mediums of present-day electric-power equipment are essentially atmospheric air, oil, paper, and porcelain. Although appreciable voltages can be withstood by these dielectric materials, they are minute to what a corresponding gap in vacuum can withstand. Fig. 1 gives the breakdown voltage of a 3/8-inch-diameter rod gap, both for air and vacuum. As can be seen in Fig. 1, a vacuum gap of 1/10 inch has a breakdown strength of 140-kv and a corresponding gradient of 1,400-kv/inch.

The reason for this high breakdown strength is the absence of air molecules between the electrodes. With electrodes in air, ionized molecules are probably the main carriers of electric charges and responsible for the low breakdown value. At atmospheric pressure and room temperature, there are about 6×10^{22} molecules of air constituents in a volume of 22.4 liters. The mean free path for an air molecule is about 7×10^{-6} cm and for an electron about 40×10^{-6} cm. However, if the vacuum is better than 10^{-4} mm Hg, the mean free path of the molecule is more than 5,000 cm and that of the electron is more than 30,000 cm. It can be seen that with a gap distance of 1 cm only a few electrons in a million will collide with molecules and, therefore, have opportunities to form ions. It is primarily this fact which is responsible for the high breakdown strength in vacuum compared to the low breakdown strength in air.

Breakdown of Gap. If the voltage between electrodes is raised to or above the values indicated in Fig. 1, a break-

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down of the gap occurs. The current during this breakdown is limited only by external impedance of the circuit, as in the case of circuit breakers. The mechanism of this breakdown is not fully understood. It appears to be started by field emission of electrons at the cathode. The impact at the anode causes vaporization of the anode film and anode metal, the latter shooting at high velocity to the cathode, causing electron ionizations in the gas, capable of supporting the high current. The voltage drop across the contacts during the current-carrying period is extremely small, in the order of voltage drops in air.

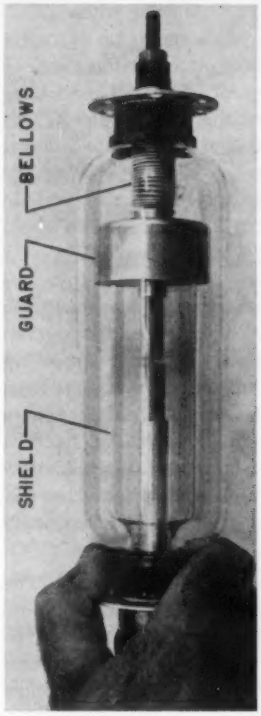
Dielectric Recovery. Upon termination of the discharge and after a deionization time of not more than 10 microseconds, even after current values of several thousand amperes, the original dielectric strength is established. This quick return of high dielectric strength is, of course, because the vaporized metal, which is localized between the contacts, diffuses rapidly because of the absence of gas molecules. The metal molecules are blown at high speeds to the glass walls and there condense.

60-Cps-Current Interruption. If a pair of contacts carrying current in a conventional high-voltage system are separated under vacuum, breakdown occurs immediately upon separation and the 60-cps current is carried to the end of the first half cycle, where it is interrupted. After current zero, deionization takes place in less than 10 microseconds. With vacuum-switch contacts separating at speeds of similar magnitude as circuit-breaker contacts (10 feet per second), the dielectric recovery strength builds up at an enormous rate. After 1/20th of a cycle, corresponding to 1/10-inch contact separation, a dielectric strength of 100,000 volts rms is available. This property suggests the use of vacuum switches to capacitor switching, line dropping, etc., where conventional breakers are subject to restrikes with all their harmful characteristics.

DESIGN AND PERFORMANCE

THE APPLICATIONS AND TESTS to be described later made use of a vacuum switch shown in Fig. 2. The switch is completely sealed and is a modification for power use of switches developed for high-frequency circuits. In the r-f switch tube, the glass shield and the metal guard are not used. Currents in r-f circuits are usually small, in the order of a few milliamperes. During the interruption of such small currents, very little vaporization of electrode metal takes place. With currents as encountered in power circuits, considerable vaporization may occur which would result in a conducting metal deposit on the inside of the container. After numerous operations, particularly at high currents, these metal deposits would form a conducting path and lead to internal breakdown. The glass shield limits the range of these deposits to safe values. The copper bellows is by nature of its function very thin and at higher currents which can produce considerable sparks, it is necessary to intercept those by a guard as shown.

The satisfactory continuous operation of a vacuum switch is, of course, dependent on the maintenance of a high vacuum, even after the current has been interrupted numerous times. Although the switches are evacuated to a



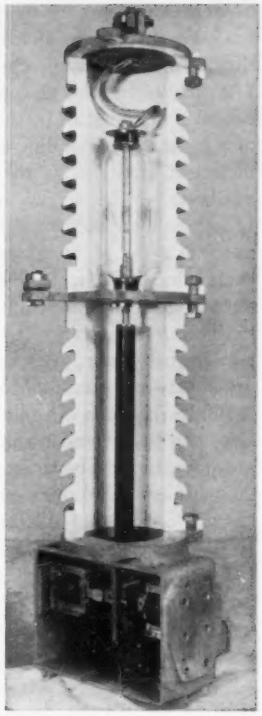


Fig. 2 (left). Vacuum switch. Fig. 3 (right). Cutaway view of Type SV-1 vacuum switch; 15 kv, 200 amperes

considerably higher vacuum, safe operation is obtained as long as a vacuum of 10^{-4} mm Hg exists. At pressures about 10^{-4} mm Hg, the free path of a gas molecule is still many times larger than the electrode separation. As has been pointed out previously by Sorensen and other investigators, it is important that the metal surfaces and electrodes within the switch be as perfectly degassed as possible. Modern processes of degassing by inductive heating and high-vacuum attainment have made this requirement possible. It is not necessary and for practical purposes impossible to completely degas the switches used; however, if operations in the number of 50,000, 10,000 or in some cases less than 1,000 are assured, then the device will offer advantages over other switching equipment now available. If the elimination of gasses is imperfect, then the vacuum will be reduced more rapidly toward the minimum allowable limit.

From tests, it has been found that high-current values lead to a faster reduction in dielectric strength than would be the case with lower current values; however, improvements are continually made. Whereas, a current of 50 amperes might be interrupted 10,000 times and more, currents of 100 amperes might permit 5,000 operations, and 250 amperes might permit 2,000 operations for a particular size of vacuum switch. These figures refer to the switch design shown and can be radically increased by larger diameter vacuum enclosures and contacts.

Application of Vacuum Switches for Use on Power Systems. The limitations of present oil circuit breakers in switching

capacitive current are well known. After an interruption has taken place, the dielectric strength builds up at such a slow rate that delayed restrikes take place often as much as 1/2 cycle later, with all their harmful effects. The vacuum switch is not affected by this shortcoming, since after 1/20th of a cycle, corresponding to 1/10-inch contact separation, a dielectric strength in the order of 100,000 volt rms is available. Whereas an oil circuit breaker can restrike 1/2 cycle after contact separation, a vacuum switch would not fail if the identical voltage would appear 1/20th of a cycle after its contact separation. Aside from the obvious advantage of restrike free performance, the vacuum switch interruption will be practically independent of contact parting time. Although developments and tests are under way on switches of various current and voltage ratings, it will be shown in the following that a wide field of applications can be covered by the switch shown in Fig. 2. The current carrying capacity of this switch is approximately 200 amperes. Impulse and 60-cps characteristics correspond to National Electrical Manufacturers Association (NEMA) 15-kv values.

Vacuum Switch for Switching Small Capacitor Banks. The single pole design shown in Fig. 3 has been developed for use with capacitor banks up to 15-kv, where the normal current is 200 amperes or less. The vacuum switch proper is mounted inside an insulating porcelain shell, which in turn is provided with corrugated petticoats for outdoor installations. The switch is actuated through an insulating rod from the grounded mechanism housing. The housing includes a closing and opening coil and such accessories as manual operating lever, operations counter, and position indicator. The device is particularly suitable for use with pole-mounted capacitor installation for voltages up to 15-kv. Fig. 4 shows an oscillogram of the closing in and opening of a single-phase 1,000 kva 12.5-kv bank by means of the switch shown in Fig. 3. A Western utility has made extended life tests with the aforementioned switch, switching a 300-kva 4.2-kv 3-phase capacitor bank. To date, in excess of 10,000 closing-and-opening operations have been performed, with performance at 10,000 operations being identical to that at the start, that is, with current interruption at the first current zero and without restrike.

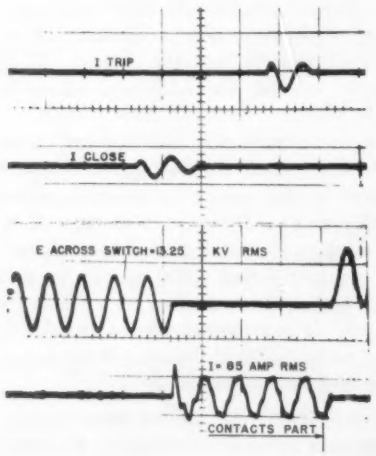


Fig. 4. Oscillogram of Type SV-1 vacuum switch closing and opening capacitor bank

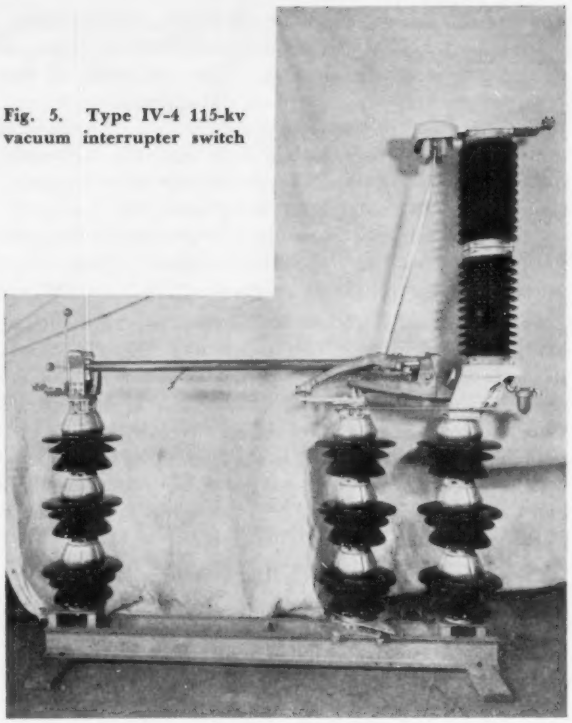


Fig. 5. Type IV-4 115-kv vacuum interrupter switch

Inasmuch as no maintenance is required, and hazards caused by oil are completely eliminated, it appears that the device is particularly suitable for pole-mounted installations. The elements of the single-pole design are now being incorporated into a corresponding three-pole design. Because of the small contact travel and contact weight of the vacuum switch, the operating solenoids are extremely small, resulting in small operating currents. In fact, the operating mechanism of the vacuum switch is smaller than the trip-and-closing mechanism alone of conventional oil switches.

Vacuum Interrupter Switches for Switching Capacitor Banks. Although the normal current-carrying capacity of the vacuum switch, shown in Fig. 2, is approximately 200 amperes, it is capable of interrupting higher currents. On endurance tests now under way, it has interrupted 250 amperes at 20-kv in excess of 2,000 times without change in performance. A large number of successful tests have been performed at 600 amperes, and still higher currents are being investigated. The extremely high-voltage with stand values suggest the use of the switch at higher voltages, possibly up to 230-kv, in which case several switch units could be used in series. In order to take advantage of the interrupting ability at currents in excess of 200 amperes, it seems advisable to provide a shunt circuit to the vacuum switch, this shunt circuit being opened prior to the opening of the vacuum-switch contact. These considerations have lead to the design of an interrupter switch, shown in Fig. 5, whose current rating is 600 amperes and whose voltage rating is 115-kv.

The interrupter switch consists of a conventional rotating

insulator vertical break-type airbreak switch to which is added one or several vacuum switches in series, as shown in Fig. 6. These switches are enclosed in a porcelain shell which is mounted on the hinge end of the airbreak switch. The vacuum switches are operated mechanically through linkages connecting to the blade mechanism. The incoming line attaches to the contact terminal, and the outgoing conductor attaches to the top of the vacuum-switch housing. In order for the combination to carry and interrupt currents in excess of 200 amperes, a shunt blade is provided across the vacuum-switch assembly. As can be seen, the shunt blade is attached to the main rotating blade. As soon as the airbreak switch mechanism is operated from the ground, the main blade rotates approximately 30 degrees and introduces a large air gap between the shunt-blade tip and the shunt-blade contact. At this instant, the vacuum switches are tripped mechanically through the tripping mechanism, interrupting the current. Next, the main blade opens fully, introducing the usual air gap.

This arrangement results in a switch which, in the closed position, meets the NEMA normal-current and high-current requirements and, in both open and closed position, meets the 60 cps and impulse hold value specifications. The switch is not intended to open fault currents or to be closed in on faults. During the closing operation of the interrupter switch, either the shunt blade or the vacuum switches switch, either the shunt blade or the vacuum switches could could be selected to perform the closing of the circuit.

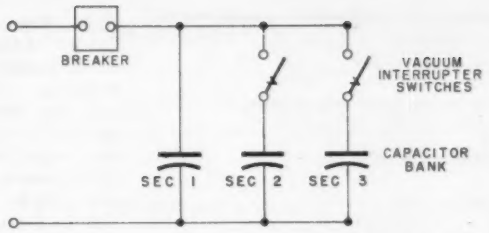


Fig. 7. Diagram for switching capacitor banks by sections with vacuum interrupter switches

Vacuum switches are capable of closing in single banks, as well as closing in bank to bank; however, the high-frequency high-magnitude inrush current of the latter operation leads to sputtering of contact material, resulting in a reduction in operating life. During the closing-in operation the final closing of the electric circuit therefore is accomplished either at the shunt-blade or main-blade contacts. This results in a short high-frequency spark, during which the considerable energy available is liberated harmlessly in the atmosphere. Where operating requirements make a reduction in the high-frequency inrush current magnitude desirable, such as might be the case in extremely large adjacent banks, a suitable resistance can be provided at the arcing contacts. This resistance is cut out when the switch is fully closed and is not in operation when the switch opens.

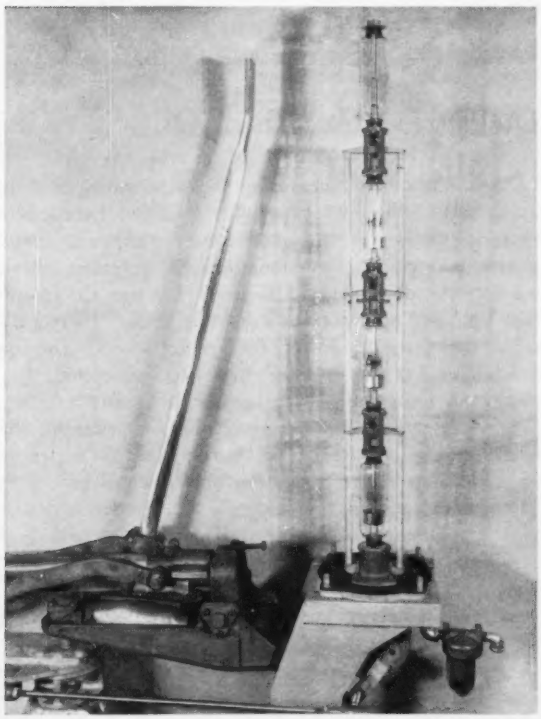


Fig. 6. View of 115-kv Type IV-4 interrupter switch with porcelain shell removed

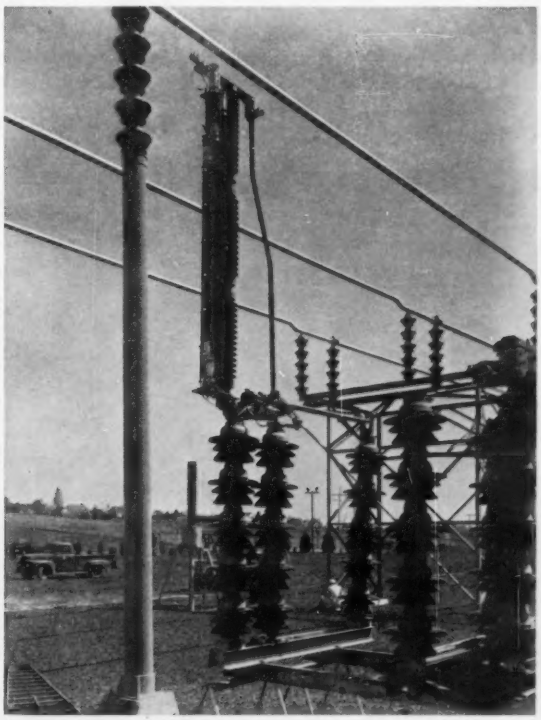


Fig. 8. Test: Type IV vacuum interrupter switch for dropping 230-kv line of Bonneville Power Administration

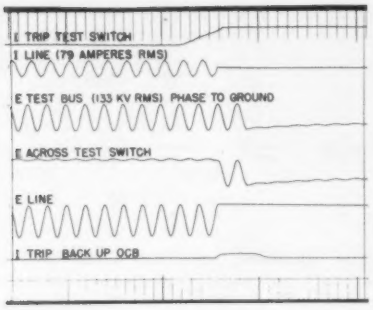


Fig. 9. Bonneville Power Administration oscillogram dropping 152.1 conductor miles, 3 parallel conductors, single phase, of the Ross-Longview 230-kv line with four vacuum switches mounted on Type IV interrupter switch shown in Fig. 8

The interrupter switch developed is ideally suited for switching sections of large capacitor banks, as shown in Fig. 7. A circuit breaker is provided for switching the first section and protects against faults in all the banks, whereas the vacuum interrupter switches switch the remaining individual sections. Trial installations of this type have been completed on 12.4 kv with a 5,400 kva bank being switched into a 5,400-kva bank, and on 115 kv with a 10,250-kva bank being switched into a 10,250-kva bank. Additional installations at 34.5 kv and 69 kv are scheduled to follow soon.

Field Tests on Switching Charging Currents on Long High-Voltage Lines. The performance of the 115-kv design shown in Fig. 5 was verified by field tests at 115-kv and 230-kv which consisted of opening the charging current of long transmission lines. On the system of the California-Oregon Power Company, an interrupter switch—using only two vacuum switch units in series—repeatedly opened 33 and 100 miles of single-phase 115-kv line. More recently, extensive single-phase 230-kv line dropping tests were made by the Bonneville Power Administration. During these tests four vacuum-switch units in series opened 50 and 150 miles of line in excess of 50 times. Fig. 8 shows the test set up; Fig. 9 shows a typical oscillogram. As can be seen, interruption occurs without restrike. These tests illustrate the high-dielectric recovery rate of vacuum switches, 260-kv rms (350-kv peak) voltage being sustained 1/2 cycle after interruption by four gaps of approximately 1/8 inch each.

CONCLUSIONS

THE EXTREME DESIRABILITY of applying vacuum switches to power systems is discussed, and the findings fully confirm those of previous investigators such as Sorensen, Mendenhall, and Koller.[1,2] Fortunately, the efforts of the radio industry have led to the production of a vacuum switch, which even in its present state of development can be used to great advantage on power systems.

Switches have been developed, tested, and installed, capable of switching capacitor banks and dropping long transmission lines in the entire voltage range from 7.5 kv to 230 kv. Performance is restrike free and exceeds that of often much more expensive conventional switching equipment.

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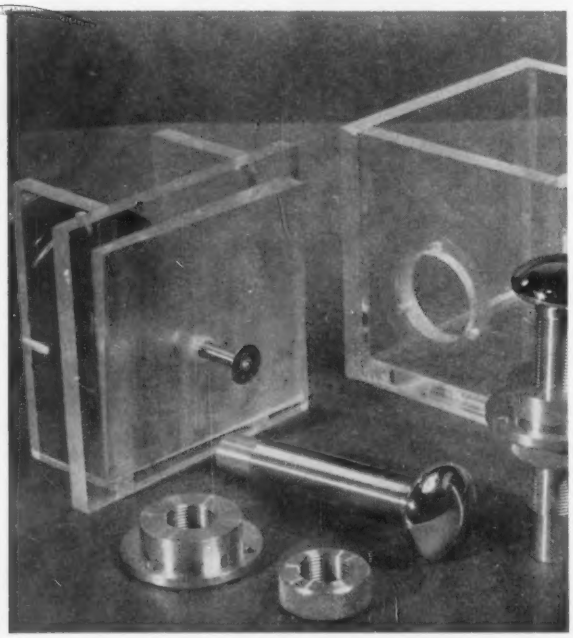
New Method for Measuring Dielectric Strength of Oil



A new test cell for measuring dielectric strength of oil, having a uniform-field gap, with modified hemispheric electrodes, a larger volume of oil in the test cup, and a small agitator to keep the oil in circulation during testing (shown at left), was developed in General Electric Company's High Voltage Laboratory at Pittsfield, Mass. Its recognition by the American Society for Testing Materials will be recommended as soon as details have been completed.

The cell measures oil strength with greater precision than the presently used standard test gap, which has parallel-plate electrodes, with edges and corners that do not represent conditions inside a modern power transformer. As transformer capacities and voltages are increased, designs must be made more and more compact and internal clearances reduced. To prevent corona formation in such designs the dielectric fields must be uniform, insulations highly stressed, and all conductor surfaces rounded, with no sharp side edges.

Testing with the present standard gap gives only gross measurement of oil degradation caused by suspended particles of moisture and other contaminants. The new uniform-field gap is sensitive to moisture and contaminants dissolved in the oil, as well as to suspended particles.

Kilovar Planning for Southern California Edison

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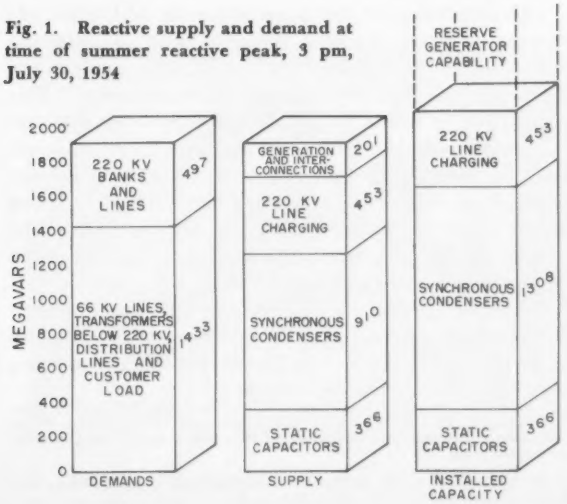
EFFECTIVE KILOVAR PLANNING, which is becoming capacitor planning for many electrical systems, requires detailed knowledge of system reactive power characteristics and operating requirements. Planning kilovar generating capacity then becomes analogous to planning kilowatt generating capacity. In both instances, load is forecast and generating capacity for the load plus appropriate reserve for system contingencies is planned.

The reactive demand and supply for the Southern California Edison Company system is shown in Fig. 1. Maximum over-all system reactive demand of 1.93 million kvar occurred in July 1954 at which time the real power demand was 1.83 million kilowatts. Charging kilovars were about equal to the reactive losses of the 1,900-mile, 220-kv system. Synchronous condensers supplied 63 per cent of 1.43 million kvar of reactive demand existing at the 66-kilovolt level and below, while static capacitors supplied 25 per cent. The reactive generating margin for system contingencies was available in synchronous condensers and in steam plants near the load center.

Fixed capacitors on 4-kilovolt circuits corrected circuit power factor to unity at light loads. Most capacitors on higher voltage distribution circuits were switched, either seasonally or by voltage control. Capacitors at substations were usually switched, either manually by supervisory control, or automatically with current biased voltage control predominating.

Growth in reactive demand at the 66-kilovolt level has been 125,000 kvar each year. In addition to planning for this load, kilovar generating margin has been planned to provide for contingencies such as transmitting large amounts of interchange power, outage of a major transmission line or synchronous condenser, or unusually heavy air-conditioning load.

Fig. 1. Reactive supply and demand at time of summer reactive peak, 3 pm, July 30, 1954



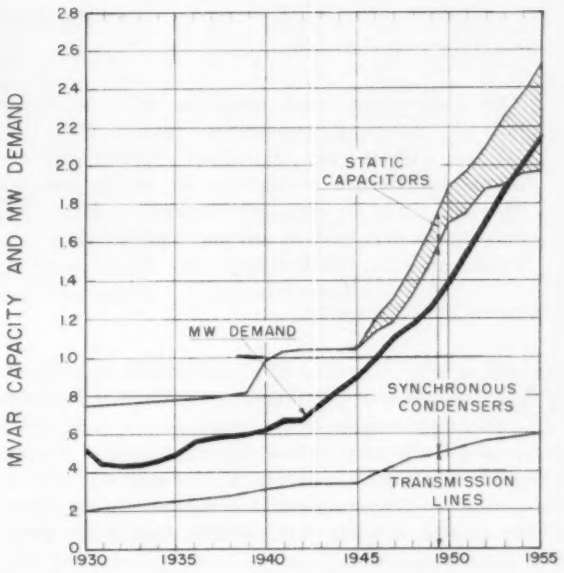


Fig. 2. Relationship between megavar capacity and megawatt demand

Static capacitors will supply the majority of this annual growth of reactive demand in the future, as shown in Fig. 2. Synchronous condensers, which for many years provided for the reactive load growth and margin, are decreasing in relative importance. This decrease is due in part to changing cost relationship between synchronous condensers and capacitors, and to the fact that fewer long transmission lines which require kilovar absorbing capabilities of condensers will be added to the system.

Capacitors will be apportioned to the various 220/66-kilovolt operating areas in accordance with the reactive load and reserve requirements. Unswitched circuit installations will be determined by minimum load power factor on circuits, and switched circuit installations will be determined by local voltage conditions. Specific substation installations will depend mainly upon available transformer taps, upon desired voltage correction, and upon required correction of 66-kilovolt subtransmission voltage level. Capacitors will be programmed for installation on 66-kilovolt busses at substations after optimum capacitor installations have been completed on the distribution voltage busses.

Digest of paper **56-2**, "Planning Kilovars and Capacitors for the Southern California Edison System," recommended by the AIEE Committee on Transmission and Distribution and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 30–February 3, 1956. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1956.

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A Flat-Bed Facsimile Telegraph Transmitter

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The construction and operation of a new facsimile telegraph transmitter developed by Western Union are described. Unlike the common type of transmitter in which the message must be wrapped around a drum, this unit is designed so that the message sheet needs no manipulation and may be of any desired length.

A NUMBER OF NOVEL FEATURES have been incorporated in an experimental flat-bed facsimile telegraph transmitter developed at the Water Mill Electronics Laboratory of The Western Union Telegraph Company. In the new machine, the message is placed on the flat bed of the transmitter and scanned by a series of closely spaced transverse lines as the sheet is advanced over the scanning line.

Such a device has several advantages over the more common type of facsimile transmitter which requires that the message be wrapped around a drum. With the flat-page or flat-bed transmitter, the message sheet requires no preparation or manipulation by the operator. It is simply laid on a table or dropped in a slot from which it is drawn by rollers through the machine. Furthermore, the sent message may be of any length.

OPTICAL SYSTEM

THE ARRANGEMENT of the basic parts of the new machine is shown in the diagram of Fig. 1. Scanning is accomplished by sweeping a spot of light, 0.01 inch in diameter, horizontally across the message sheet from left to right at a uniform speed and returning the spot quickly, at 19 times the forward speed, to the left margin to repeat the cycle again and again as the message is advanced slowly at a uniform speed transversely across the scanning line. Light reflected from the message is collected by a cylindrical reflector, concentrated on a photocell, and converted into electrical currents whose intensities are proportional to the reflected light at each instant.

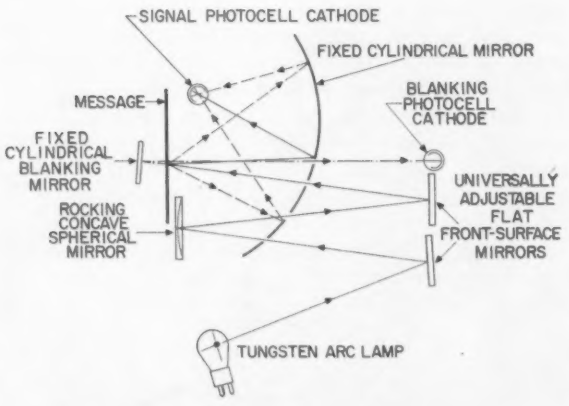

Fig. 1. Optical system of flat-bed facsimile scanner

Tungsten Arc Lamp. The scanning light source is a miniature tungsten arc lamp, Fig. 2, developed specifically for facsimile use. It has a tungsten ball cathode, 0.01 inch in diameter supported on the end of a 0.004-inch diameter tungsten wire, and a molybdenum disc anode, both mounted in a small glass bulb filled with argon gas.

The lamp operates from a special rectifier power unit which first delivers a high-voltage pulse to start the arc and then supplies a direct current of about 100 milliamperes at 40 volts to maintain the arc.

During operation, the tungsten ball is maintained at incandescence by the heat of the arc to produce an extremely small, uniformly bright, stable, and well-defined point source of light. It can be focused with a single lens or mirror directly on the message in the facsimile transmitter without the use of the condensing lenses and pinpoint aperture, such as are required to produce an effective point source from the ordinary tungsten filament lamp usually employed in a "flying spot" scanner. The elimination of these elements by the use of the new lamp avoids expensive optics, results in a brighter scanning spot and reduces the length of the optical path.

The new tungsten arc lamp offers an additional advantage over the tungsten filament lamp for facsimile transmitter use in that the light output of the tungsten arc is relatively constant with changes in lamp current. This comparison is shown in Fig. 3. A 10-per-cent increase in current causes the light output of the tungsten filament lamp to increase 93 per cent. Under a similar current increase, the light output of the tungsten arc lamp increases only 7 per cent. Thus, it is not necessary to operate the tungsten arc lamp from a voltage regulator as is required for the tungsten filament lamp in this service.

During the life of the tungsten arc lamp, the tungsten ball gradually evaporates until it is reduced to the diameter of the supporting wire. This occurs after 200 to 300 hours

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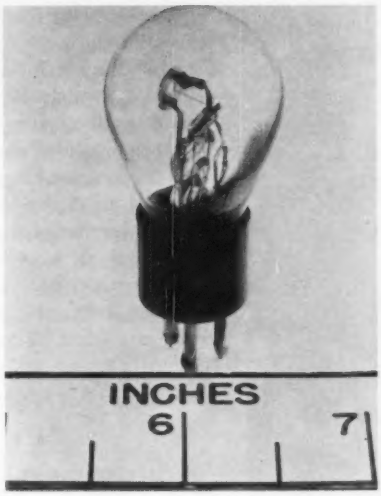


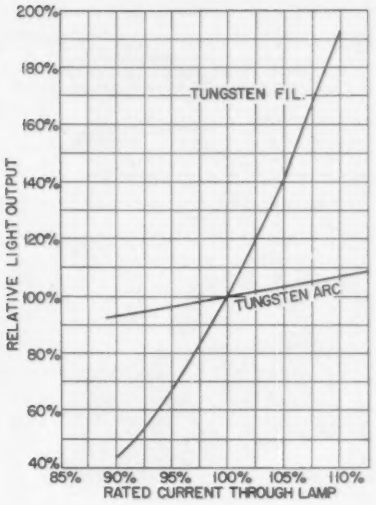


Fig. 2 (right). Tungsten arc lamp. Fig. 3 (far right). Variation of light output with current for tungsten filament lamp and tungsten arc lamp

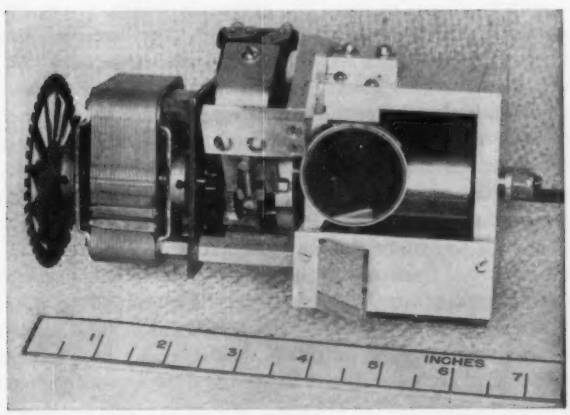
of use. The lamp can then be renewed by reversing the polarity and sending 10 times normal current through it for an instant so as to form a new tungsten ball on the end of the wire. This cycle can be repeated several times before the lamp is discarded.

Rocking Mirror. In the new flat-bed transmitter, light from the tungsten arc is collected by a concave spherical mirror which then reflects the image of the incandescent tungsten ball in the lamp as a small bright spot of light on the face of the message. This mirror is a simple plano-concave lens, $1^3/_8$ inches in diameter, whose concave spherical surface has been coated with aluminum to form a concave mirror with a 20-inch radius of curvature. The mirror is placed so as to be substantially equidistant from the light and its image. Thus, the optical system works at unity magnification and the high focal ratio of $14^1/_2$. Under these conditions it is possible to produce a very high-grade image of the source with very low-cost optics. Flat mirrors are interposed in the optical path between the lamp and the concave mirror and again between the concave mirror and the message to direct the light beam back and forth so as to reduce the over-all space required for the optical beam.

The concave mirror is mounted on supports so that it can be rocked through an 11-degree arc by a motor-driven cam. This motion causes the image to sweep across the message at a uniform speed during 95 per cent of the time of 1 revolution of the cam and to return to the starting point in the remaining 5 per cent of the time. The cam is made of nylon impregnated with molybdenum disulfide. This material combines the advantages of quiet operation and long life of the nylon with the low friction properties of the molybdenum compound. The mirror mount is made of aluminum, in order to have little mass. As a result, it has been found possible to operate such a rocking mirror at speeds up to at least 30 times a second or 1,800 rpm. The cam-operated mirror, with the associated motor, light chopper, speed-reducing gears, and clutch of a 180-rpm unit is shown in Fig. 4.

Cylindrical Mirror and Photocell. While the spot of light scans the message from left to right for a distance of about 8 inches and returns quickly to repeat the cycle, the message is advanced transversely across the scanning line at a speed which produces 100 scanning lines to the inch of the message sheet. As the spot scans across the sheet, the light which is reflected from the message is collected by a cylindrical reflector and brought to a focus as a line of light on the photocell cathode.

The photocell is of a type which has a long narrow



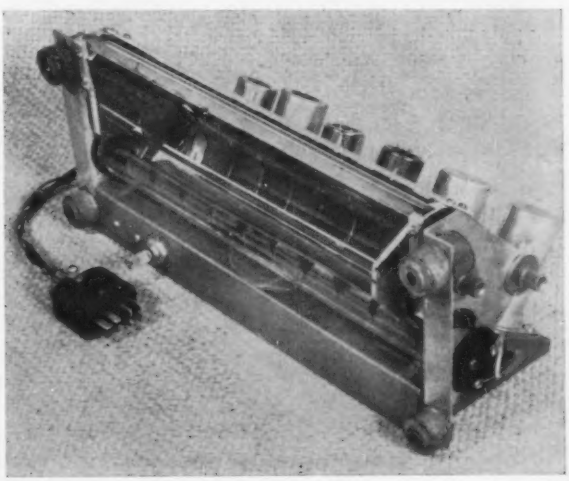


Fig. 4 (above). Swinging mirror, cam, and light chopper assembly. Fig. 5 (right). Photocell, reflector, and amplifier assembly

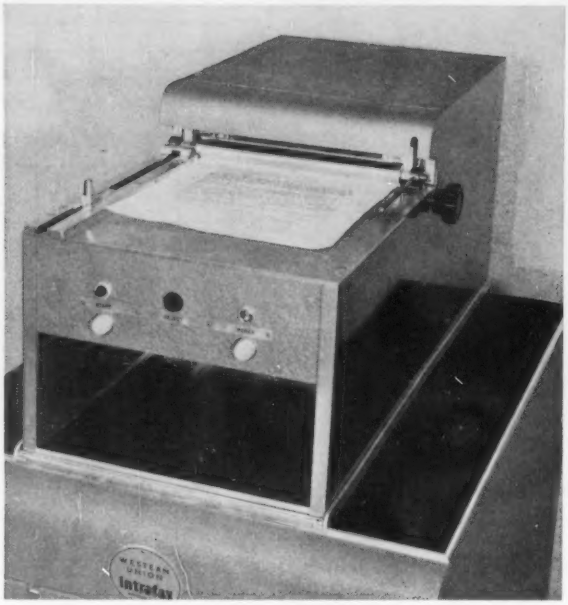


Fig. 6. Private wire transmitter

light-sensitive surface so as to pick up as much as possible of the line of light generated by the cylindrical reflector. With this combination of cylindrical reflector and photocell, the whole length of the photo cathode collects light all of the time regardless of the position of the spot of light along the scanning line and, thus, avoids the usual requirement for such service that the photo cathode be equally sensitive at all points.

The cylindrical mirror collects the reflected light over an average solid angle of more than 90 degrees. If the reflected light is assumed to have a Lambert cosine spatial distribution, it can be shown that the cylindrical reflector collects more than 50 per cent of the total reflected light. This collecting system is so efficient that an ordinary gas photocell provides ample signal output.

If the message being sent through the new machine is narrower than the scan-line length, the scanning spot falls on a cylindrical mirror back of the message during the part of its sweep when it is off the message. This mirror sends the light into a photocell which operates to blank the inverter signal. This arrangement automatically provides a white background over the entire width of the received copy regardless of the width of the transmitted message.

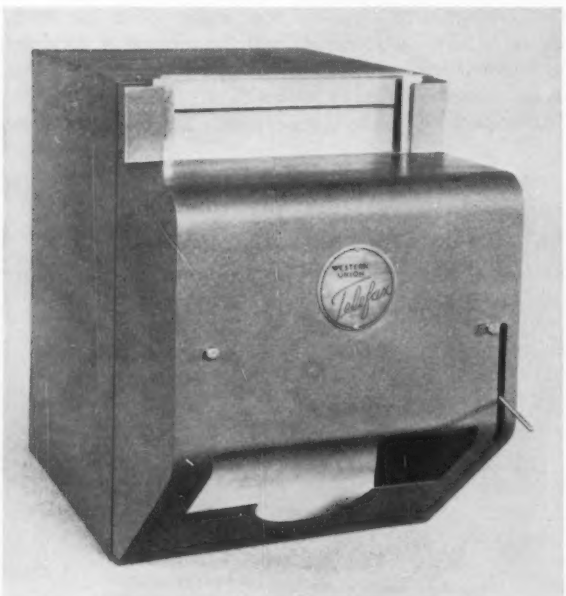


Fig. 7. Concentrator-type transmitter

ELECTRICAL SYSTEM

A CHOPPER WHEEL interrupts the light from the lamp at 2,700 cycles per second to produce a modulated signal from the photocell that can be handled by an a-c amplifier. This 2,700-cycle carrier frequency is sufficiently high to transmit the 1,200-cycle frequency produced by the 180-rpm scanner. A 5,400-cycle chopper is used on 360-rpm machines.

A resistance-capacity coupled amplifier is used to amplify the modulated signal from the photocell. The amplifier is equipped with a time-delayed automatic volume control which holds the output of the amplifier constant within 1/10 db as the input changes slowly over a 10 db range. This arrangement assures that the amplifier, over its range of control, will produce a constant signal from the message background, regardless of its color. Thus, the amplifier adjusts itself automatically to the correct gain to produce from the recorder a copy which will have a white background and yet not fail to record light copy such as pencil marks that may be on the original message. The photocell, cylindrical reflector and amplifier assembly is shown in Fig. 5.

MECHANICAL SYSTEM

THE VARIOUS ELEMENTS of the flat-bed scanner may be selected and arranged in any convenient form to fit the requirements of the particular service in which it is to be used. Fig. 6 shows a machine designed to handle copy up to $8^1/_2$ inches in width for private wire service. In use, the message is placed on the flat table of the machine with the feed roller resting directly above the part of the message at which transmission is to start. A pointer at the edge of the table is adjusted to the line on the message where transmission is to end. If a message longer than the standard 11-inch sheet is to be sent, the end-of-message pointer is drawn to the extreme end of its travel. The machine will then transmit the copy, whatever its length, until the end of the sheet has passed the scanning line.

When the machine starts, the sheet is fed at high speed to bring the message quickly to the scanning line. The rate of feed is then reduced to normal during transmission and at the end is again increased to feed the message sheet into the "sent" message compartment.

A flat-bed machine designed for Western Union con-

centrator service is shown in Fig. 7. Here, standard length telegrams, 8 or $8^1/_2$ inches in width, are dropped into a slot on the front of the transmitter. If the message does not fill the entire message box, an indicator bar set just below the signature will cause the machine to terminate the transmission at that point. When the start signal is received, the message is time-stamped on its face automatically and then fed at high speed to bring the top of the message box to the scanning line. At the end of the transmission, the sheet is fed at high speed into the "sent message" box at the bottom of the machine.

Since the new experimental flat-bed transmitters require little of the operator, it becomes possible to equip the new transmitters with automatic message loaders. The operator then puts the messages which are to be sent into the automatic loader and it, in turn, delivers the messages to the transmitter as required, one at a time and in sequence. Such a device is under development.

Although models have been made of the transmitter described here, further experimentation and considerable laboratory and field testing will be done before any decision is made to undertake production of this type of Telefax device. Evaluation studies based on such tests are now in progress.

A Comparison of Rotating, Electronic, and Magnetic Amplifier Regulators

J. P. MONTGOMERY

A review of regulator principles and a comparison of the three popular types, as presented, make these electric-circuit tools more useful and more readily adopted. In industry, they are applied as voltage, current, speed, tension, and position regulators, to name but a few of the many applications.

REGULATORS of the rotating, electronic, and magnetic-amplifier types are tools with which an engineer works to solve the problems created by the growth of automation. As requirements for process drives to operate at higher speeds, for longer uninterrupted periods, and to produce better products become more stringent, so the requirements for the regulators become more exacting.

By strict definition, a regulator is an automatic device for maintaining or adjusting the current, speed, tension, position, etc., of a machine, transformer, or the like. However, in current usage, the term has become broadened to encompass more nearly a system made up of several components, than a device. In this sense, regulators are applied to control almost every phase of industrial processes.

The problem of application of regulators is one of mutal concern to the user, the machinery builder, and the designer. This stems from the fact that each shares in the responsibility for the ultimate success of the application. Such a responsibility can best be met if the over-all design is based on a commonly shared understanding of the desired results and the limitations to the achievement of these results, which must be imposed by the various system components used.

Inasmuch as the regulator element, or amplifier, is only one component in the system and cannot completely compensate for deficiencies in the characteristics of other parts of the system, the problem is much simplified if considered in two steps: (1) fundamental regulating-system requirements; and (2) comparison of regulator elements, or amplifiers.

There is no substitute for good system design. New applications are always a challenge, and recent years have seen the development of analytical methods for predetermining many regulating-system requirements. These techniques, coupled with sound judgment based on experience in many fields, insure good results and promise even greater achievements in regulator application. The fundamental requirements for good regulating system design can be summed up under three headings: (1) control accuracy; (2) response time; and (3) stability.

The regulating system for incorporating these into the control of a machine is called a feedback control system. A simple analogy to such a system is a person driving an automobile down a road. The requirements are that he maintain an ideal position, with reference to his half of the road, and that he follow that road as it winds its way to its destination. As the car moves, the driver compares its position with the center of his half. The deviation from the desired course is a measure of control accuracy. How quickly he is able to regain the desired course when a deviation occurs is response time. His ability to correct for

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deviations in a minimum time with the least overshoot is a measure of stability.

As drivers, some make better regulators than others. One can detect a small deviation better than another; one is stronger than another; one moves quickly to correct; and one overcorrects in going around a sharp curve. Performance is always best if the road is good and clearly marked, and there is no crosswind. Everything becomes more critical as car speed increases, and the driver soon realizes that a correction at one speed is not the same at another.

REQUIREMENTS DEFINED

CONTROL ACCURACY may be defined as the degree of correspondence between the ultimately controlled variable and the ideal value. A measure of this accuracy is the deviation from the ideal. This deviation may be a result of changes in the system components, the power supply, the load, or the reference setting. These changes may be considered as disturbances to the ideal system. Component changes may occur in the reference element and in the sensing or command element, as well as in the regulator element itself. They may be a result of temperature change; motor, generator, or tachometer end play; tachometer brush drop; regulator brush drop; tube drift; rectifier aging; etc. Such changes have their major effect on the steady-state accuracy of the regulator. Careful design, selection, and co-ordination of the components will minimize these disturbances.

A system deviation may occur as a result of voltage or frequency changes in the power supply. If these are erratic in nature, they will appear as disturbances. If they are in the nature of a voltage or frequency drift and are carried to extremes, they will directly affect the system gain, response time, and forcing ability. It is important in a well-designed regulating system to know the characteristics of the power supply.

Changes in system load usually constitute the greatest variable. The load on a drive may build up to a value and remain essentially constant or may be in the nature of an impact. The latter results in a transient deviation which may exceed the steady-state deviation. In choosing a regulator system, and the regulator element to put therein, it is important to know the characteristics of the anticipated load. The system mechanical inertia has a direct bearing on the transient deviation, as well as system response time.

Changing the reference setting may impose an even more severe transient deviation on the system and, in many instances, necessitate incorporating either a time rate or a limit-type control. In addition, for a given set of circuit parameters, the control accuracy is a direct function of the reference setting. In a system having a deviation of ± 1 volt, if the reference is set at a maximum of 100 volts, the control accuracy is ± 1 volt out of 100 volts, or ± 1 per cent. If the reference setting is reduced to 10 volts, the control accuracy at this setting becomes ± 1 volt out of 10 volts or ± 10 per cent. For this reason, control accuracy is generally expressed as a deviation in per cent of the maximum value of the controlled variable.

Control accuracy under steady-state conditions is directly a function of system gain or amplification; i.e., high accuracy requires high system gain and results in minimum deviation. Control accuracy under transient conditions is also a function of system gain, but must be evaluated in terms of system response time.

Gain can be defined as the ratio of the change in output from the system for a given change in input to the system, when measured in the same terms. Usually, volts are the unit of measure; thus, if a change of 1 volt across the field of a generator will produce a change of 10 volts in its output the generator is said to have a gain of 10. A practical measure of regulator gain can be obtained by a comparison of the deviation of the system without a regulator to the deviation of the system with the regulator.

Although a single time-delay system is inherently stable, a system with two or more time delays may be oscillatory for high values of gain and for certain relations between time constants. This means that damping may be necessary in order to obtain the desired degree of stability.

From these observations it can be concluded that to obtain high control accuracy, it is desirable to have high gain. When this is obtained through an amplifier in a system having more than one time delay, it becomes important for stability purposes that the amplifier delay be as near to zero as possible; at any rate, it is desirable to have a low amplifier time delay with respect to other system components.

Stability can be defined as the property of a system or element whose response to a disturbance dies down if the disturbance is removed. A system can be stable in one region of operation and not in another. An unqualified statement that a system is stable means that the system is stable under all normal operating conditions and for all types of disturbance normally encountered. This is particularly important in any system subject to oscillatory loads or impact loads having a regular frequency of application.

Thus consider the three types of regulators available, namely: rotating, electronic, and magnetic amplifier. In making this comparison, consideration is given to (1) what each regulator is, (2) its prin-

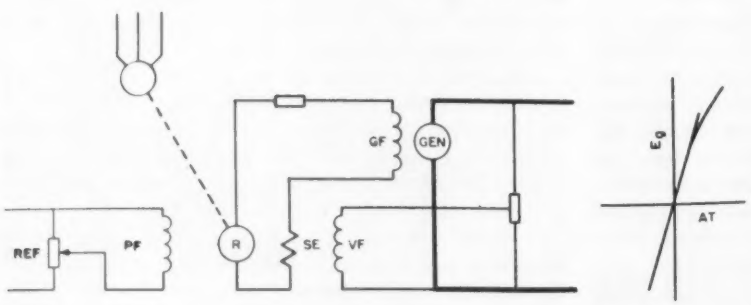


Fig. 1. Basic voltage-regulator circuit using a rotary regulator

ciple of operation, and (3) how it is used. Later comparisons are made of (4) advantages, (5) disadvantages, and then (6) some typical applications are presented.

ROTATING REGULATORS

THE ROTATING REGULATOR fundamentally is similar to a standard d-c generator. It requires a drive motor which takes power from the a-c line and converts it into rotating energy. It then reconverts this energy to a controllable d-c output which can be used either to excite the field of another machine or directly in the armature circuit.

This type of regulator works by virtue of the fact that it supplies within itself essentially all the excitation required to maintain its own output. Thus, only a very small amount of external control energy is necessary to produce large changes in output.

This concept, as embodied in the Rototrol, makes use of a series self-energizing field. Fig. 1 shows our basic voltage regulator circuit using a rotating regulator.

A characteristic curve of voltage output versus excitation for a typical rotating regulator is shown in Fig. 2. By operating the regulator in the range where the output voltage is proportional to excitation, i.e., the relationship is a straight line, it is possible to devise a sensitive fast regulator with considerable forcing range. The control is the degree of saturation of the iron of the rotating machine.

A very important characteristic of rotating regulators is their ability to reverse polarity. By merely reversing the polarity of the reference field, the voltage of the regulator may be brought to zero and caused to build up in the opposite direction. This becomes an important consideration when attempting to regulate at extremely low speeds or voltages, or acceleration and deceleration at high rates are required, or the application requires reversing of the controlled machines. Rotating regulators have a distinct advantage in that they can regenerate energy back into the line. Through the use of multiple fields, the input, output, and damping circuits may be isolated electrically from each other.

ELECTRONIC REGULATORS

CONVENTIONAL multielement vacuum tubes working in conjunction with power tubes, such as thyratrons and ignitrons, make possible the electronic amplifier of today.

Most amplifiers use an input stage consisting of a vacuum tube. A measure of the controlled quantity is compared with the ideal reference, and the difference is used to control the grid of this tube. The power stages of electronic amplifiers are tubes which are filled with either mercury vapor or an inert gas. Such tubes have the property of greatly multiplying their ability to conduct as a result of ionization of the gas or vapor. They are employed as power rectifiers and are also controlled by means of a grid.

In the case of the rotating machine, the degree of saturation controls the output. Here, however, the output is controlled by regulating the time during any positive half cycle when complete ionization is allowed to occur.

Consider the thyratron as it is used to supply a machine field, as shown in Fig. 3. The purpose of the field rectifier is to convert the alternating current supplied by the anode

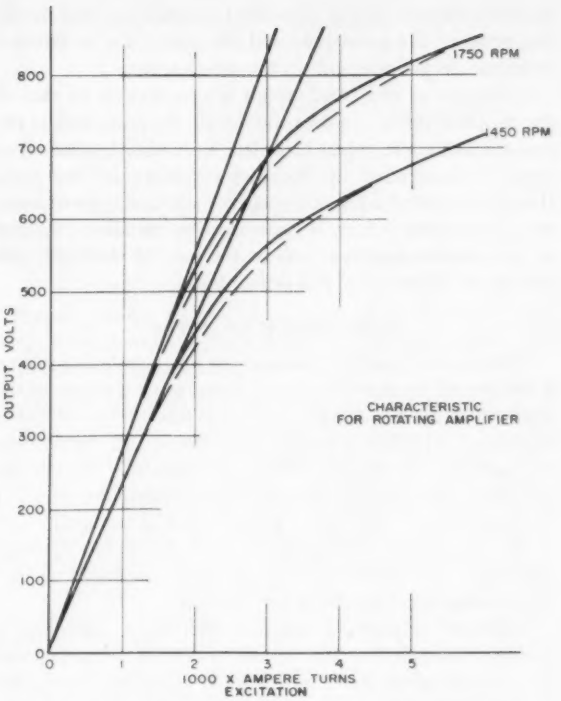


Fig. 2. Characteristic curve of voltage output versus excitation for typical rotating regulator

transformer into direct current for the generator or motor shunt field. By proper control of the thyratron grid potential, the direct voltage applied to the load may be controlled over a wide range. The amount of current is determined by the load impedance, and the maximum allowable current is determined by the rating of the thyratrons, selenium stacks, and anode transformer.

The combination of such a power output stage with a preceding vacuum-tube amplifier stage make possible gains not easily attained by either rotating or magnetic amplifiers.

MAGNETIC-AMPLIFIER REGULATORS

THE UNDERLYING PRINCIPLE of the magnetic amplifier, while it has been understood since the early 1900's, has only found practical industrial application in the last few years. Its present rank in the field of industrial regulators is made possible only through the tremendous advances made in the development of magnetic materials, dry-type rectifiers, manufacturing technique, and improvements in circuitry during and since World War II. Special alloys, such as Hypernik, Hypersil, and the improved Hypernik V used as core materials, and selenium rectifiers, having low reverse leakage currents, long life, and minimum aging, have made this possible.

The magnetic amplifier, in its fundamental concept, combines some of the characteristics of both the rotating and electronic amplifier. First, it uses reactors consisting of magnetic cores, on which are wound both power output windings and control windings. These are subject to saturation, hysteresis, residual, and inductive time-delay

effects. Second, it is a controlled rectifier inserted in the line between the a-c supply and the load. Fig. 4 shows a magnetic amplifier circuit in the simplest form.

Operation of this basic circuit is very similar to that of the gas-filled tube. In the tube circuit, the point during the positive half cycle, when complete ionization is allowed to occur, is controlled by the direct voltage on the grid. Here, the point during the positive half cycle, when complete saturation occurs, is controlled by the direct voltage on the control winding. As in the case of the electronic circuit, the current flow is unidirectional.

COMPARISON OF TYPES

THE SELECTION of the elements for any regulating system is influenced by many factors. A thorough analysis of the application must be made in order to answer the following questions: (1) What is the job to be done? (2) What control accuracy is actually required to produce the desired product? (3) What is the nature of the system disturbances that will occur? (4) What is the nature of the load? (5) What is the operating range over which the equipment must perform? (6) What are the physical conditions at the place where the equipment will be used?

Stringent production requirements may influence a decision towards the use of the regulator requiring the very least maintenance; on the other hand, the customer's familiarity with a specific type of regulator may influence the decision in its favor.

In order to help make such a decision, a comparison of the advantages and disadvantages of the three basic types of regulators can be made. First, consider the rotating types, which are generally capable of system gains in the order of 5 to 25; although, in specific cases, gains as high as 50 have been obtained. The power input requirements for such regulators are relatively high—generally, in the order of about 10 to 40 watts. Power output from a single-stage amplifier of this type is in the order of about 15 kw, although higher outputs are attainable through the use of two stages of amplification. Such regulators are very flexible because they provide isolation between the control-input and the power-output windings. There is a wealth of experience in the application of such regulators to many types of drives, and they are simple in their operation and maintenance. They are readily understood by most mill operating personnel. When regular routine maintenance procedure is followed they are highly reliable and, because of their relatively rugged design, can be depended on to give long service. Their chief advantage lies in their reverse ability without special circuit components. They are relatively easy to check and adjust on initial startup and should trouble occur usually require only the tools available in most shops to trouble shoot. They may be applied in such a way as to take advantage of the stored energy in other machines or fly wheels to provide protection in case of power failure. In most cases, they are unaffected by external signal disturbances.

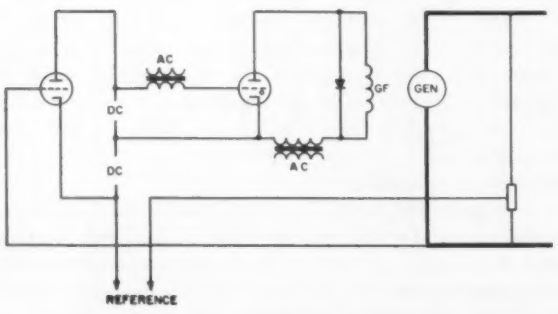


Fig. 3. Thyratron used to supply a machine field

Electronic regulators (electronic amplifiers) are capable of system gains in the order of 500 or above. Their power-input requirements are extremely low and may be in the order of microwatts. For this reason they are readily applied where the signal source is a phototube, a thermocouple, or some other such low-energy device. Here, response time is extremely low. They are readily adapted to almost any application except that they have a unidirectional output and are not readily reversible without the addition of a separate channel. For most mill electricians, they are not simple in either circuitry or operation. A routine maintenance schedule, rigidly adhered to, provides a fair degree of reliability, but tubes must occasionally be replaced because emission from the cathode is no longer satisfactory, or they may fail in operation. Signal power requirements are in the order of microwatts. They are readily adapted to include anticipating and damping means and have a distinct advantage in being able to incorporate elements to provide rate or current limits.

Magnetic-amplifier regulating systems may be designed to obtain system gains of about 100. Signal-input requirements are generally in the order of a few milliwatts. They are in the in-between class in speed of response. However, where this factor is extremely important it is possible to use magnetic amplifiers designed for use with special high-frequency power supplies, such as 400 cycles, in order to reduce the response time. They are flexible in their application, again because of the isolation of the control circuits from the output circuits. Their chief advantage lies in the fact that they consist of components which do not wear out or lose their efficiency and ability to operate continuously for indefinite periods of time, and they require no maintenance. Trouble shooting can be accomplished through the use of readily available shop tools. They have a unidirectional power output, but reverse polarity can be obtained by proper connection of duplicate channels.

Both the electronic and magnetic amplifiers are readily incorporated in the structures containing other control equipment and, therefore, do not necessitate the additional wiring usually required in the case of rotating amplifiers.

In making a selection, the application engineer must consider (1) gain; (2) response time; (3) power input; (4) power output; (5) reversibility; (6) range; and (7) signal strength.

The requirements to be met under these headings are fixed by the application and are primary factors in choosing the regulator element and associated components of the system; they are (1) reliability; (2) simplicity; and (3) maintenance and durability. These factors are important.

They often influence the choice between those elements which meet the foregoing requirements. In some cases, they may be given enough weight to override a choice based on the primary factors alone. An attempt to evaluate these various factors for easy comparison is made in Table I.

A steady-state accuracy of ±1 per cent of the maximum value of voltage current or speed, over a range from no load to full load, and an operating range in the order of 6 to 1 are attainable with a single stage of amplification using either a Rototrol, a magnetic amplifier, or an electronic regulator. This accuracy presumes that the reference, the signal, and the associated machine characteristics are carefully chosen; in the case of either the Rototrol or the magnetic amplifier, a self-energizing circuit is used. Systems falling in this category are generally not too difficult to stabilize.

When it is determined that the operating requirements call for greater accuracy than this, the inherent characteristics of the amplifiers begin to take precedence. Even greater care must be taken in the selection of the associated circuit components and, generally speaking, the complete operating characteristics of the proposed system must be known and carefully considered. A thorough analysis of the regulating problem is often necessary; such systems are studied on computers. By taking full advantage of these things, system accuracies in the order of ±0.5 per cent for rotating regulators ±0.25 per cent for magnetic amplifiers, and ±0.1 per cent for electronic regulators are possible. To obtain such accuracy it is generally necessary to make use of two stages of amplification and, in so doing, the problem of stability becomes increasingly difficult.

APPLICATIONS

OF THE MANY APPLICATIONS throughout industry, for example, some typical of the rubber and plastic field are:

Rotating regulators. (1) Applied as booster-type regulators to maintain constant current in pull-roll and tension-roll motor armature circuits on rubber calender tandem installations; the important requirement is reversibility of regulator output voltage and current; (2) Applied as a speed regulator with tachometer feedback to maintain rubber calender speed constant at a predetermined value; in this particular application, pull and tension rolls as described in example 1 were also used, and rotating regulators were used throughout; (3) Applied as a speed regulator using tachometer feedback to maintain time test machine speed constant; and (4) Applied to maintain essentially constant windup tension at the end of a calender-coating process by controlling the field of the windup motor to hold armature current constant.

Table I. Relative Rating of Three Regulator Types (Numeral 1 Is Highest Rating)

	Rotating	Electronic	Magnetic
Approximate maximum system gain as speed regulator	50	500	100
Speed of response	3	1	2
Power input at maximum gain	3	1	2
Power output	1	2	3
Reverse power	1	2	2
Flexibility of application and design	2	1	1
Simplicity, reliability, and maintenance	2	3	1

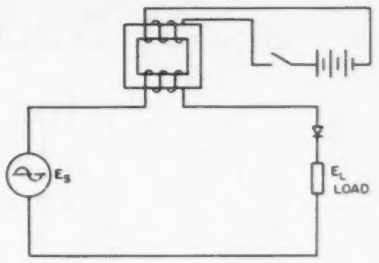


Fig. 4. Magnetic-amplifier circuit in the simplest form

Electronic regulators. (1) As speed regulators with tachometer feedback on cellulose-acetate film-casting machine drives; and (2) As speed regulators with tachometer feedback on nylon process drives. (In both 1 and 2, several sections are matched to a master reference over a range of operating speed and the individual motors have both motoring and regenerating loads.) (3) As speed regulators on plastic film or sheet-extruder drive; (4) As loop position regulators in conjunction with both dancer roll actuated reactors and photoelectric devices; and (5) As speed-matching regulators on wire insulating machine drives to match capstan speed to extruder speed over wide product speeds, as well as relative speed ranges.

Magnetic Amplifiers. (1) Applied to provide current limit acceleration and tachometer feedback speed regulation on aircraft tine and brake test machine drives; (2) Applied in combination with dancer operated rotary inductor, as loop position regulators on tread cooling conveyor drives and opaque plastic film machine drives; and (3) Applied to control the field of a d-c motor-driven alternator to hold speed and frequency constant; this application used a frequency sensitive input; the magnetic amplifier was energized from the driven a-c generator. In the event of a-c power failure in the plant, the d-c to a-c set was run from a battery supply; the alternator was used as an instrument power supply.

Dual Picture-Tube Carts

A new high-production system for aluminizing television picture tubes, in which each cart evacuates and coats two tubes with a single vacuum pumping system, has been developed by the High-Vacuum Equipment Division, F. J. Stokes Machine Company, Philadelphia, Pa. Earlier aluminizing equipment has handled only one tube per cart. The new dual-tube carts can process two 21-inch picture tubes in a $6^1/_2$-minute cycle, and the standard 5-cart continuous system, operating around a circular track 17 feet in diameter, will turn out 96 finished tubes per hour. Five additional carts can be added to the standard dollies, to produce 21-inch tubes at a rate of 192 per hour. Up to 27-inch tubes can be accommodated.

A Nuclear Reactor Simulator for Teaching Purposes

L. ORR W. KERR (MEMBER AIEE) H. J. GOMBERG (MEMBER AIEE)

The nuclear power reactor furnishes an excellent illustration of many of the principles and problems involved in the field of nuclear engineering. The design and operation of a portable electronic reactor simulator suitable for teaching purposes are discussed.

PERHAPS the most interest-provoking situation in which controlled nuclear reactions are used in an engineering application is in the nuclear power reactor. This application is a good one for teaching purposes, because it illustrates several types and complexities of nuclear measurement. The larger problem of correlating these measurements with measurements of temperature, flow, etc., and using this information to control the reactor is also worth considerable study.

The nuclear power reactor is part of an integrated system in which a nuclear reactor serves as a source of power, say in a steam-electric generating station. The problem has several interesting facets, that of reactor control, that of the control of the steam-electric part of the system, and the over-all problem of determining the dynamic behavior of the integrated complex. Fig. 1 shows a block diagram of a possible simplified arrangement of such a system.

Using the appropriate unclassified literature and reasonable engineering approximations, a set of equations can be written to represent the flow of energy and information in the system.[1,2,3] Two items are of primary concern: nuclear kinetics in the reactor itself, and heat transfer in the reactor and the heat exchanger. In addition, since most reactors are designed so that the reactivity is a function of temperature, the interrelationship of the two must be established.

Investigation shows that because of this relationship between reactivity and temperature, the system has many of the characteristics of a feedback amplifier. It can thus be treated analytically by the well-developed techniques that are available for the analysis of feedback amplifiers and automatic control systems. In most cases of interest, the reactor kinetic equations are nonlinear, hence the additional interesting problem of treating nonlinear differential equations is introduced.

Several useful approaches to the problem are available. One of these involves linearization of the equations, and a subsequent application of the linear theory of feedback systems, such as the Bode diagram type analysis, to investigate system stability.[4] This approach is interesting not only because it leads to useful results in this situation, but also because it is so widely applicable to problems in the automatic control of large systems.

The effect of the nonlinearity may also be treated, and appropriate unclassified publications are available.[5,6] Again the method of treating the problem may be much more generally applicable than to this specific situation.

ANALOGUE COMPUTERS

AS AN ALTERNATIVE or as a supplement to the analytical approach, it may be desirable to use an analogue computer or reactor simulator to study system performance. The use of the simulator allows the nonlinearity of the system to be treated with facility. The simulator also allows easy and rapid variation of system parameters, and exhibits the changes in system performance which result therefrom.

An important advantage of an analogue computer is that as one observes solutions developing on the recorder, an intuitive "feel" for system performance is developed. This may be much more difficult to achieve from a purely analytical treatment.

The simulator which is used to treat the reactor power plant study can be either very elaborate or fairly simple. Although the simpler types have less precision, they have the advantages of compactness, portability, and low cost. They serve admirably as demonstration units for teaching purposes.

PORTABLE UNIT

A PORTABLE REACTOR SIMULATOR has been constructed at the University of Michigan which is of sufficient accuracy for teaching purposes. The equations simulated are, using the notation of Bell and Straus,[7]

$$dN/dt=(\delta k_{eff}/kl^*)N-(\beta/l^*)N+\epsilon^{\tau\Delta}\sum_i \lambda_i C_i+\frac{(T-T_0)K_1}{l^*}N+S \tag{1}$$

$$\frac{dC_i}{dt}=-\lambda_i C_i+(\epsilon^{-\tau\Delta}/l^*)\beta_i N \tag{2}$$

$$Q=M\frac{dT}{dt}+W(T-T_C) \tag{3}$$

Here, in addition to the symbols defined by Bell and Straus:

T = temperature of the lumped reactor
T_0 = reference temperature of reactor
T_C = average coolant temperature
K_1 = temperature coefficient of reactivity
Q = reactor heat output, directly proportional to N
M = thermal capacity of reactor fuel elements
W = heat transfer coefficient from reactor to coolant

BASIC CIRCUIT

THE BASIC CIRCUIT used to simulate the reactor proper is essentially that of Bell and Straus. This circuit is an

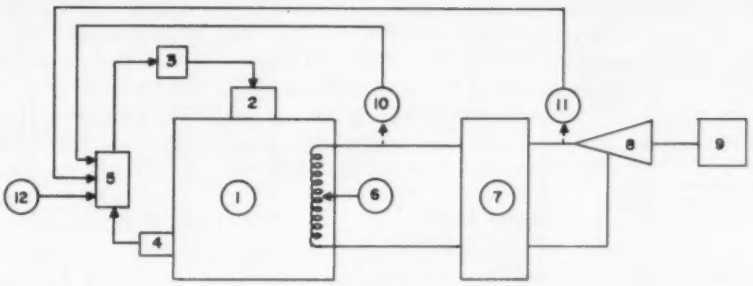
analogue of the one group, namely thermal, point reactor equations. Five neutron delay groups are included.[8]

In addition, the effect of temperature rise in the reactor core caused by increased power level is also simulated. The position of the control rods, or δk_{eff}, the coolant flow rate, the "source" magnitude and the temperature coefficient of reactivity K_1 are under the control of the operator from the front panel.

A block diagram of the circuit is shown in Fig. 2. A push-pull high gain d-c amplifier A is connected as an integrator with feedback capacitor C_1. The output voltages of $+N$ and $-N$ are proportional to the time integral of the input current Σi, while the input voltage remains substantially constant. The panel voltmeter V_n indicates the neutron flux N at any instant. A current source i_0 simulates the production of prompt neutrons, the rate being determined by the setting of the δk_{eff} control and the level of N.

Current sources $i_1 \ldots i_5$ represent the delayed neutrons, and the time constants of the delay networks, $\Delta_1 \ldots \Delta_5$, are set equal to the mean lives of their precursors. The time constants are fixed at the values: 0.62, 2.20, 6.52, 31.6, and 80.2 seconds. The delay fraction of each source is adjustable individually. The total delay fraction or per cent of delayed neutrons represents about 0.75 per cent of the total neutron production under steady-state conditions. There is a primary fixed source i_s which is independent of level N, but which is manually adjustable. A current K_1NT is also added to the integrator input representing the effect of temperature on reactivity.

The loss due to neutron absorption and diffusion out of the reactor core region is given by i_d. This current is proportional to the level N. The sum Σi of all currents including the negative current i_d denotes the excess neutron production and determines the rate of change of reactivity. When $\Sigma i = 0$, for example, the reactor neutron population is constant.



1. Reactor
2. Control rod drive
3. Transducer, error signal to control rod drive
4. Neutron measuring device
5. Comparator
6. Heat transfer, reactor core to coolant
7. Heat exchanger, reactor coolant to steam
8. Turbine
9. Electric generator
10. Coolant temperature and flow measuring device
11. Steam temperature and flow measuring device
12. Power demand input

Fig. 1. Block diagram, reactor power plant

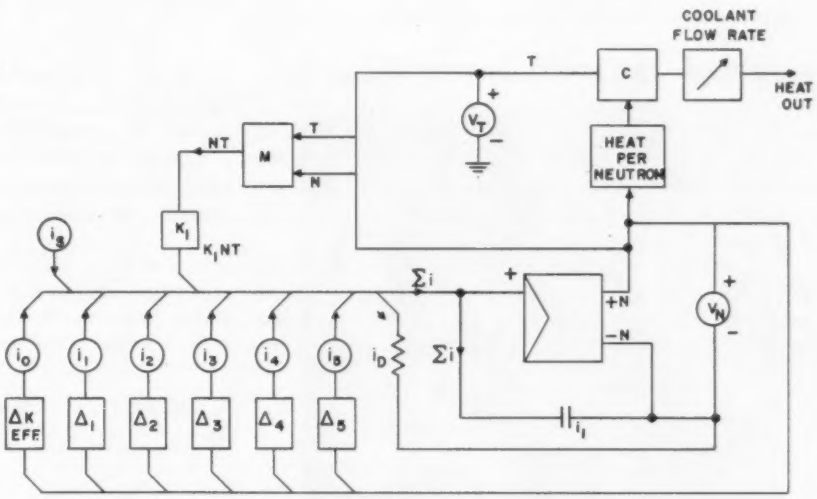


Fig. 2. Block diagram of reactor simulator

A current proportional to the $+N$ voltage is fed to a capacitor C. This represents the heat input to the reactor, and C represents its thermal capacity. A control simulating the coolant flow rate, determines the current flow rate out of capacitor C, and represents the rate of removal of heat from the reactor by the coolant. It is assumed that heat loss by radiation and conduction is small compared to that removed by the coolant. The voltage V_t on this capacitor represents the mean reactor temperature and is indicated by the panel voltmeter V_t.

As mentioned previously, the effect of temperature variation on the reactor is obtained by feeding an additional source of neutrons K_1NT to the integrator input. K_1 is the temperature coefficient of reactivity, and is negative in practical controlled reactors. Thus, the current contribu-

Full text of a paper presented at the Nuclear Engineering and Science Congress, Cleveland, Ohio, December 12–15, 1955, and recommended for publication by the AIEE Committee on Nucleonics.

L. Orr, W. Kerr, and H. J. Gomberg are with the University of Michigan, Ann Arbor, Mich.

The authors gratefully acknowledge the interest and financial assistance of the Dow Chemical Company in the construction of this simulator.

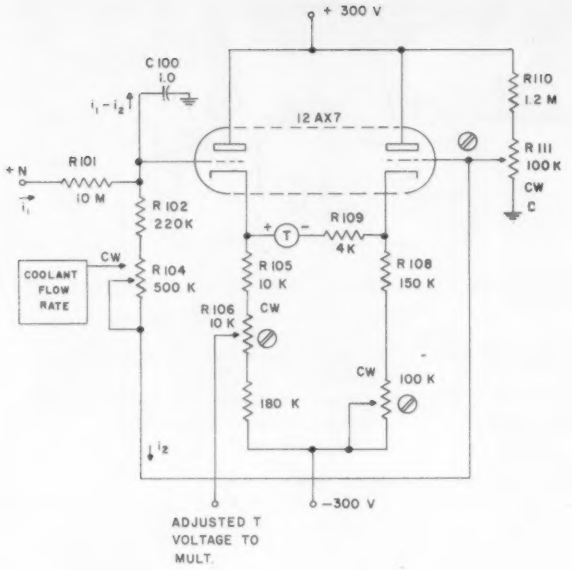


Fig. 3 (left). Temperature circuit and coolant flow rate control

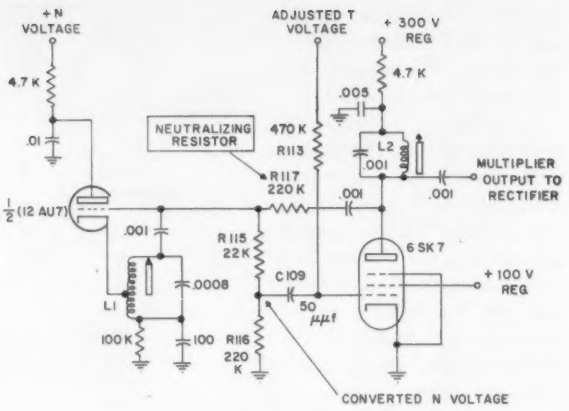


Fig. 4 (above). *N* voltage converter and electronic multiplier

tion is actually negative. Because this contribution is proportional to the product of flux level N and temperature T, an electronic multiplier M is used to obtain the required product. The output of the current generator K_1 in the diagram is the required current, and is added to the integrator input. The magnitude of temperature coefficient of reactivity K_1 is under the control of the operator.

The circuits used to accomplish the desired result are grouped into two sections. The first section contains the prompt and delayed neutron sources, the source balance control, the δk_{eff} control, the electronic integrator, and the N meter. The circuitry associated with this section is quite similar to the original Bell and Straus[7] circuit, except that the δk_{eff} control is equipped with a vernier adjustment.

The second section contains the temperature circuit, coolant flow rate control, T meter, the N voltage converter, electronic multiplier, and the K_1 control.

TEMPERATURE CIRCUIT

A SIMPLIFIED VERSION of the temperature circuit (Fig. 3) shows the coolant flow rate control and T meter. The current i_1 represents the heat generated in the reactor, and this

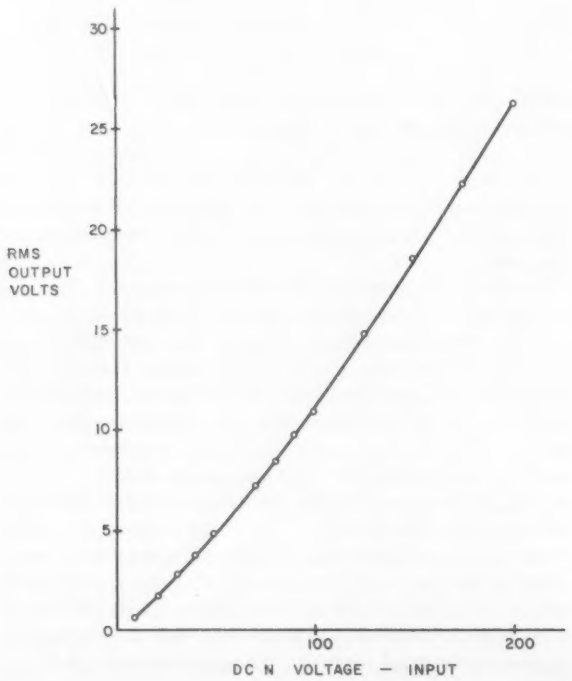


Fig. 5 (left). *N* voltage converter response

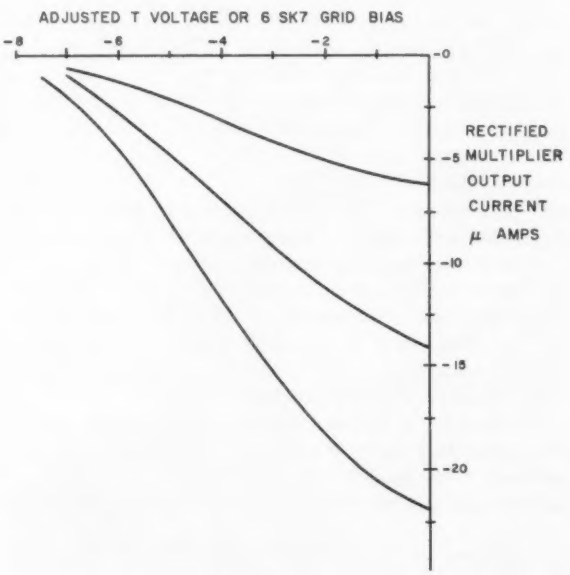


Fig. 6 (above). Multiplier response

flows into capacitor C_{100} representing the thermal capacity of the reactor. This current is proportional to the voltage difference between the $+N$ voltage and the capacitor voltage, which is always small compared to $+N$. The current i_2 flowing out of C_{100} through R_{102} and R_{104} represents the heat removed by the coolant, and this is proportional to the capacitor voltage. The capacitor voltage represents the mean reactor temperature and is indicated by the meter T. Spatial variation of temperature throughout the volume of the reactor is not represented in this simulator, since a lumped reactor is simulated.

When the net capacitor current i_1-i_2 is zero, the mean reactor temperature remains constant. Changing the setting of the coolant flow rate control R_{104} varies the current i_2, representing a change in the coolant flow rate. The temperature changes, thus changing reactivity until a new stable operating power level is established.

To give a suitable output to the electronic multiplier, an adjusted T voltage is required. This is furnished by the tap on R_{106}. For the temperature corresponding to the stable shutdown value, this control is adjusted to give an adjusted T voltage of -8.0 volts.

THE N VOLTAGE CONVERTER

THE N VOLTAGE CONVERTER is a 330-kc Hartley oscillator. This is shown at the left side of Fig. 4. The N voltage is decoupled, and used as the $B+$ supply voltage to the oscillator. The circuit constants and bias values are so arranged that the amplitude of the oscillator output is approximately proportional to the N voltage over a fairly wide range of values, as indicated by the curve in Fig. 5. This converted N voltage is used to feed the input of the electronic multiplier.

ELECTRONIC MULTIPLIER

THE PRODUCT NT is required for simulating the effect of temperature upon reactivity. The circuit performs this function by generating a source of "negative" neutrons proportional to K_1NT as described previously. Since K_1 is generally negative in actual reactors, the current K_1NT is bled off from the integrator input, as indicated in Fig. 2.

The circuit performing the multiplication is accurate to several per cent over the range of useful operation. Although perhaps not adequate for accurate computation, it is satisfactory for demonstration purposes. It is based on the principle that certain variable gain tubes have a transconductance versus grid voltage curve closely approximating a straight line. The *6SK7*, operated at a fixed screen voltage of 100 volts, gives an almost straight-line relationship between transconductance and control grid voltage in the region of control grid voltages from -8 to -2 volts. The circuit in Fig. 4 shows the method of obtaining zero gain at $e_c=-8$ volts by adding the neutralizing resistor R_{117}.

The converted N voltage is fed to the grid of the *6SK7* through C_{109}, while the adjusted T voltage, which is the grid bias, is fed in through R_{113}. The plate load is a resonant tank tuned to oscillator frequency, and the output is taken from the *6SK7* plate. This output is zero for $e_c=-8$ volts, and for other values is proportional to product NT.

The multiplier output is rectified, and fed to a d-c amplifier and inverter stage having as its output a current proportional to K_1NT. The multiplier response is indicated in Fig. 6 for three values of N voltage. The output current is negative for a negative setting of K_1, which is the normal mode of operation, and this current is drawn from the integrator input as described previously.

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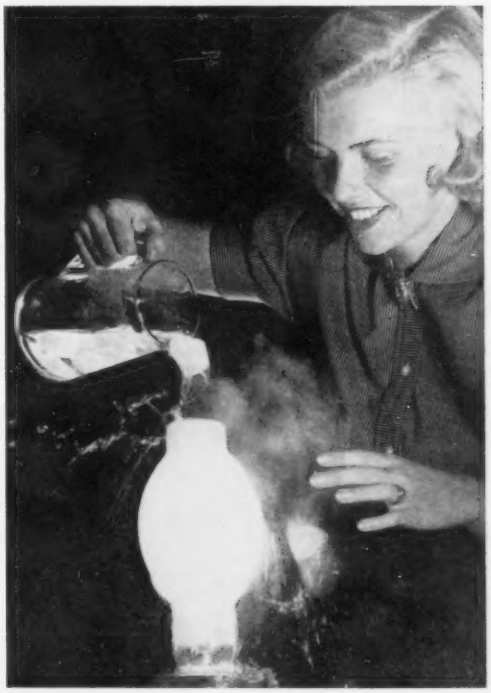
Weatherproof Mercury Lamps



A new line of weatherproof heavy-duty mercury and fluorescent-mercury lamps available from the Westinghouse Electric Corporation uses an outer bulb of a special hard, tough glass for maximum resistance to damage from weather and mechanical hazards. In outdoor applications, the outer bulb permits the new Weather Duty (registered trade mark) lamp to be installed in open fixtures. Indoors, the lamps are well suited for use wherever moisture, corrosive vapors, or mechanical hazards require a heavy-duty lamp.

This line supplements the standard line of mercury and fluorescent-mercury lamps in 400- and 1,000-watt ratings.

INSTITUTE ACTIVITIES

This Year's Winter General Meeting in New York City Draws Record Attendance

OVER 5,000 MEMBERS from all parts of the United States and Canada were present at the 1956 Winter General Meeting held in the Statler Hotel in New York City from January 30 to February 3. This was the largest annual winter gathering in the 72 year history of the Institute. There were 209 technical papers presented, and 229 conference papers.

On the Sunday afternoon before the meeting, an informal tea was held which was a great success. Other social events included a ladies' get-acquainted tea on Monday, a men's smoker Tuesday, a dinner-dance on Thursday, and a variety of inspection trips throughout the week.

President of the AIEE, M. D. Hooven, opened the General Session on Monday afternoon with an address about the amazing electrical developments which will help create the push-button home of the future (page 215, March 1956 issue).

After Mr. Hooven's speech, the Paper Prizes were presented to the winners who are listed in this issue. The Alfred Noble Prize was then awarded to R. L. Bright by E. R. Needles, president of the American Society of Civil Engineers.

The keynote address was given by R. M. Blough (page 317, this issue), following the Honorary Membership Presentation made to Past President J. F. Fairman.

On Tuesday afternoon, at a special session, L. A. Umansky received the Thomas A. Edison Medal. This presentation was reported on page 228 of the March 1956 issue.

Another special feature of the Meeting was the presentation, on Friday, of the Volta Scholarship to Giuseppe Biorci. This scholarship was established in 1927 by the American-Italian Society to commemorate the 11th anniversary of the death of Allesandro Volta, the Italian scientist. Its purpose is to establish closer ties between Italy and the United States by establishing a scholarship for a young Italian electrical engineer to study in an American School for one year. It has been administered by the AIEE since 1950.

Institute Paper Prizes. The winners were selected by the Committee on Prize Awards of which W. R. Brownlee, of Birmingham, Ala., is chairman. The awards were as follows:

First prize for the best student paper went to M. C. Biedebach, University of Southern California, for "An Analysis of the Linear Pulsed Oscillator"; second prize to Arvin Grabel, New York University, for "The Linear Pulse Stretching Circuit."

Institute prizes awarded on a Division basis were:

Communication Division. First prize for "A Transatlantic Telephone Cable" to M. J. Kelly, G. W. Gilman, Bell Telephone Laboratories, Inc.; and Sir W. G. Radley, R. J. Halsey, Post Office, United Kingdom; second prize for "New Military Carrier Telephone Systems" to G. H. Huber, W. F. Miller, and C. W. Schramm, Bell Telephone Laboratories, Inc.

General Applications Division. First prize, Martin Simon, General Electric Company, "Considerations in Applying D-C Traction Motors on Rectified Single-Phase Power"; second prize, C. G. Martin, Jack and Heintz, Inc., "Thermal Developments in Aircraft Generators."

Industry Division. First prize, A. R. Kelly, Standard Oil Development Company, "Relay Response to Motor Residual Voltage During Automatic Transfers"; second prize, T. H. Lee, General Electric Company, "Transient Analysis of a D-C Electromagnet with Cut-Out Switch."

Power Division. First prize, A. H. Kidder, J. H. Neher, Philadelphia Electric Company, "Power Distribution System Parameters"; second prize, E. D. Early, G. L. Smith, Leeds and Northrup Southern Services, Inc.; R. E. Watson, "A General Transmission Loss Equation."

Science and Electronics Division. First prize, R. L. Bright, Westinghouse Electric Corporation, "Junction Transistors Used as Switches"; second prize, R. W. Roberts, R. I. Van Nice, "Influence of ID-OD Ratio on Static and Dynamic Magnetic Properties of Toroidal Cores."

LEFT TO RIGHT: L. A. Umansky, Edison Medal Winner, 1955; Comfort Adams, 87 years, consulting engineer, one of the oldest members of AIEE, and Lamme Medal Winner; M. D. Hooven, president of AIEE.

Technical Program

Instruments and Measurements. At the opening session of the Committee on Instruments and Measurements, Monday morning, January 30, three papers were presented. E. B. Curdts, James G. Biddle Company, Philadelphia, Pa., presided. The first paper entitled "Electric Potential Changes at Surfaces as a Means of Measuring Odorous Atmospheric Contamination," by C. R. Chapman and J. R. Eaton, Purdue University, was presented by Mr. Chapman. He discussed the design of the experimental measuring circuit in which the sensitivity of contact potential difference measurements to surface impurities provides a measure of the amount of contamination in the atmosphere; the apparatus can measure changes of potential within ± 0.1 millivolt. He described the many tests which were run, using different electrode surfaces and contaminants. Slides showed measuring circuit and test results. Questions were asked regarding electrode metals and surface preparation.

The second paper on "Two New Total Radiation Pyrometers," by W. Derganc and S. N. Howell, Servo Corporation of America, was given by Mr. Derganc. He described the instruments for measuring amounts of radiation, for materials in process or in laboratory experiments. Slides were shown of the circuits and of calibration curves; and the questions that followed were in regard to instrument uses at very high temperatures and instrument tubes.

The last paper, "Segmental Multi-Recording Instruments," was given by George

Keinath. He discussed recent developments in the design of multisegmental recorders, which give better presentations of recorded data and can be used for as many as 500 variables to one recorder. They have the advantage of much higher speed, of saving in panel space, and of savings in cost per recorded variable.

Solid-State Devices. L. A. Griffith of the Minneapolis-Honeywell Regulator Company presided over a Monday morning session dealing chiefly with transistors and their applications.

J. M. Early of Bell Telephone Laboratories presented a paper "High Frequency Junction Transistors," discussing diffused-base transistors capable of delivering up to 70 milliwatts at 200 megacycles, with current densities up to 2,000 amperes per square centimeter.

In a paper entitled "Discussion of a New Type Power Transistor," Joseph Maupin of the Minneapolis-Honeywell Regulator Company described tetrode operation of a new alloy-junction transistor. Advantages include improved linearity, higher gain at high current densities, and good switching characteristics.

R. L. Bright of the Westinghouse Electric Corporation presented his paper, "Recent Developments in Silicon Power Rectifiers." These rectifiers have become available commercially within the past year. Some of the properties of silicon rectifiers are high peak inverse voltages, low forward voltage drop, high rectification efficiency, high temperature operation, rugged construction, and compactness. Currently available units are capable of handling 50 to 300 volts per cell, with a current density of 500 to 1,500 amperes per square inch.

PRESIDENT OF THE AIEE, M. D. Hooven (right), is seen congratulating J. F. Fairman, vice-president, engineering and rates, Consolidated Edison Company of New York, Inc. Mr. Fairman was made Honorary Member of the AIEE.

The uses of transistors in f-m receivers were discussed in a paper by G. A. Allard of the General Electric Company entitled, "Partial Transistorization of a Communication Receiver." He explained that although a typical f-m receiver using vacuum tubes consumes about 35 watts at an audio level of 1 watt, a fully transistorized receiver with the same sensitivity and audio output would consume approximately 3 watts in Class B operation. Therefore, transistorization is particularly attractive in mobile receivers operating from batteries. The f-m receiver described in the paper uses transistors in the second i-f amplifier-limiter, audio amplifier, and squelch circuit.

FISHER BLACK ADDRESSING the Public Relations Workshop at the Section Delegates Conference at the Tuesday afternoon session.

In "Temperature Stabilization in Transistor Amplifiers," L. M. Vallese of the Polytechnic Institute of Brooklyn covered a novel method of analysis of the thermal behavior of transistor amplifiers by introducing the temperature incremental equations of the transistor and of its associated d-c network.

A. G. Milnes of the Carnegie Institute of Technology presented a paper, "Transistor Power Amplifiers with Switched Mode of Operation." He pointed out that a switched mode of operation for these amplifiers results in very low power loss, hence low temperature rises in the transistor. Thus, the transistor retains appreciable power handling capabilities up to high ambient temperatures. A number of switching circuits were described.

Land Transportation. During the week, three sessions were given over to the latest electrical developments in land transportation. These were devoted to papers in the fields of heavy traction, Diesel-electric modernization, and insulation testing. One of the papers in this division which was of interest was that given on Monday by J. L. Swarner, Pullman-Standard Car Manufacturing Company, in which he described the high-speed Train X being built for the New York Central Railroad. This new train is to have a central electric power source to operate its lighting system and its air conditioning and heating system, in contrast to the axle-driven generators, individual generators, and batteries found on the conventional passenger car. Electrical equipment on the 5-car Train X will weigh 15,000 pounds in contrast to the 67,200 pounds on a 6-car conventional coach train.

330-Kv Systems. At a session of the Power Division, Tuesday morning, five papers were given on the design, performance, and testing of the 330-kv systems. T. J. Brosnan, Niagara Mohawk Power Company, presided. The first paper entitled, "Lightning and Corona Performance of 330-Kv Lines on the American Gas and Electric (AGE) and Ohio Valley Electric Corporation (OVEC) Systems," by W. S. Price, S. C. Bartlett, and E. S. Zoble, AGE Service Corporation, described the testing which has been carried on for several years in planning for the expansion of their 132-kv system into a much larger 330-kv system suitable for use in years to come. Radio influence tests are reported for various high-voltage conditions and resulting corona effects. An unusually high incidence of flashovers from lightning was experienced, indicating a need for further extension of lightning prediction theory. Special tools and techniques have been developed so that hot-line maintenance work, as insulator replacement, may be done at 330-kv levels.

The second paper, "Line-Dropping Tests on a 330-Kv Oil Circuit Breaker," was prepared by Otto Neaf, AGE Service Corporation, and R. E. Friedrich, Westinghouse Electric Corporation. A large number of 330-kv oil circuit breakers are required to interconnect the 15 private utilities of OVEC with AGE to supply the Atomic Energy Commission's (AEC) diffusion plant at Portsmouth, Ohio. The high degree of service reliability and prevention of unscheduled interruptions demanded careful investigation of circuit-breaker performance. Over a hundred 3-phase test breaks on open-line lengths of 42, 114, and 185 miles were made with this breaker and it was found to be completely restrike-free.

The next paper, "330-Kv Power Transformer with Compensation To Provide Accurate Low-Voltage Metering Potential," was written by P. S. Pugh, AGE Service Corporation, and T. G. Gerwing, Westinghouse Electric Corporation. The 330-kv interconnections required to supply 1,800 mw of power to the AGE plant from many sponsoring companies needed metering at two tie-line points of the energy and reactive interchange. It was found possible, when two 3-phase 14,000-kva 330/4.3-kv power transformers were built for these points, to eliminate the need for additional 330-kv potential transformers for metering voltage by designing special load-compensating networks into the transformers, and thus saving $100,000 per transformer.

The fourth paper, "Relay Protection for the Ohio Valley Electric Corporation 330-Kv System," by H. C. Barnes, A. Hauspurg, and J. H. Kinghorn, AGE Service Corporation, was presented by Mr. Hauspurg. The 330-kv high-voltage high-power system for the AEC power project offered new problems of protective relaying. Mr. Hauspurg described the basic philosophy of the protective system, the important problems encountered, and the solutions adopted. Speed, load-

VOLTA SCHOLARSHIP winner, Giuseppe Biorci, is flanked by President M. D. Hooven (*left*), and H. S. Osborne (*right*), chairman of the Volta Fund.

carrying ability, and assured backup protection were emphasized. Fault kva exceeded any ever before encountered, and required the development of circuit breakers having 25-million kva interrupting capacity.

The last paper, "Sleet Melting on 330-Kv Lines of American Gas and Electric Company and Ohio Valley Electric Corporation Systems," by C. F. DeSieno, C. A. Imburgia, and G. H. McDaniel, AGE Service Corporation, was delivered by Mr. DeSieno. Sleet can be melted on the 330-kv lines by utilizing the power losses in the conductors. A sleet-prevention program involves adequate weather forecasting to predict sleet formation, 132-kv source points for supplying reactive requirements without excessive voltage drop, preparations for switching personnel to needed points in the system, and removal of facilities from normal operation.

Management. L. R. Gaty, Philadelphia Electric Company, presided over a Tuesday morning session in which two conference papers were presented on recent advances in management.

C. J. Beller of the Cleveland Electric Illuminating Company presented the interesting paper on "Effective Salary Administration" in which he described the salary administration plan in the area of supervisory and professional employees, as developed at his company over the past several years. He believes that in technical areas there is room for improvement in wage plans, and that "in the engineering profession, where an acute personnel shortage exists, it is even more important to make sure that the salary levels are fair and equitable." The company recognizes two important tools: first, a position evaluation plan; and second, a performance appraisal plan. At the start, job descriptions were completed for a pilot group of 105 representative positions, before the remaining 700 jobs were rated for duties and responsibilities. When appraising the individual, such factors as job performance and personal characteristics were considered. Charts were shown to illustrate how the factors are evaluated in points. Mr. Beller said that "the plan has helped to create a feeling of confidence among our supervisors and specialists." Discussions followed with respect to who makes the appraisals and judges on standard grades, the overrating of employees by supervisors, and the number of employees per supervisor.

J. H. Rubel, Hughes Aircraft Company, spoke on "Systems Engineering Administration." He said that an engineering organization should be designed in the same manner as an engineering system, a fire-control system, or any large project; it should have low distortion, stability, feedback, growth, and ability to handle large and small jobs. Planning, or "engineering the engineering organization," is an important function; and employees as components should be adaptable to the systems. Managers should be interested in motivation, team work, orientation, and communication.

MISS MADELINE APUZZI makes out the tag for G. O. Perkins of the I-T-E Circuit Breaker Company, the 5,000th person to register at the Winter General Meeting.

System Engineering and Computers. A Tuesday morning session was under the joint sponsorship of the AIEE Committees on Computing Devices and System Engineering. E. E. George of Ebasco Services, Inc., presided.

Loss evaluation through use of economic dispatch computers was the subject of two papers. The first, by E. L. Harder of the Westinghouse Electric Corporation and W. H. Osterle of the West Penn Power Company, discussed the principles and applications with emphasis on nonconforming loads; the second, by R. B. Squires and R. T. Byerly of Westinghouse, and H. W. Colburn and W. R. Hamilton of West Penn, covered the design considerations. A discussion was presented by R. H. Travers of Ohio Edison Company.

In a paper, "Digital Computer Solution of Power Flow Problems," by J. B. Ward and H. W. Hale, a method is presented for solving on digital computers the power flow problem, probably the most frequently encountered type of problem in the field of power system network analysis.

"The Use of Analogue Computers in Power System Studies," by J. E. Van Ness of Northwestern University and W. C. Peterson of Michigan State University was presented by Mr. Van Ness. It was pointed out that with the expanded use of digital computers in power companies, there has been a tendency to overlook the possible use of analogue computers, which are advantageous in certain applications. Work conducted at the Northwestern University computational laboratory, using a network analyzer and operational analogue computer, was described.

New Electron Tubes. In a session on new electron tubes, held Tuesday morning, W. Van Haste, Bell Telephone Laboratories, discussed statistical techniques applied to tubes in the 4,000-mile transmission Bell system. Reliability must be stressed, he said, and the utmost co-operation must exist between the tube designer, manufacturer, and ultimate user. In discussing the cost of tubes it was brought out that the equipment development carried the cost of tubes, which are very expensive due to their high quality and the close tolerances demanded.

Another paper presented during this session was "Design of a 5-kw Ceramic Power Tetrode" by F. C. Johnstone of Eitel-McCullough, Inc. One of the great advantages of ceramic tubes is that they can be heated higher than those made of glass and so will not crack nor melt in high-frequency applications, i.e., about 30 mc. They can also be held during manufacture to closer tolerances than glass tubes and they are more rugged. However, they are more expensive. The new 5-kw tetrode has four ceramic rings of alumina oxide on the tube base, and connections to the tube's elements are made through them to a new type of socket. Cooling fins are brazed onto the anode, thus eliminating soldered construction.

At this same session, P. E. Dorney of Roger White Electron Devices, Inc., described microwave applications of gaseous discharges. After telling about the gaseous makeup of the several tubes, he showed how they were used as noise sources, which can be built into sets so that the sets can be field-tested.

Telegraph Systems. In the session on telegraph systems, held Tuesday morning, a transistor type printing telegraph transmitter-distributor with unusual features was described by H. C. Isaacs, Western Union Telegraph Company. Some of its novel features are: tape sensing by means of a light source and photodiodes; conversion of the photodiode output into start-stop telegraph signals by means of transistor circuits; an output speed of 100 to 250 words per minute; and single character stepping. Although this unit was developed for military use, the methods and circuits utilized are applicable to the development of a commercially feasible model.

On Tuesday afternoon, a new experimental flat-bed facsimile telegraph transmitter was the subject of a paper by W. D. Buckingham of the Western Union Telegraph Company. In this machine, the message is placed on the transmitter's flat bed and is scanned by a spot of light, using a tungsten arc lamp as a source. This method is an advance over the one wherein the message is wrapped around a cylinder and then scanned, for the circumference of the cylinder is a limiting factor in the length of the message that can be transmitted.

Instruments and Measurements. On Tuesday afternoon, at the session on instruments and

measurements, a voltage-dip amplifier was described by H. R. Lenz of Philadelphia Electric Company, which has been using the device to measure small voltage drops that cause light flicker. This apparatus uses a portable oscillograph incorporating a holder for Polaroid-Land film, and a fluctuation amplifier. Its use has been limited thus far to measuring variations caused by welding units.

Relays. Frank von Roeschlaub of Ebasco Services, Inc., presided over a Tuesday afternoon session sponsored by the AIEE Committee on Relays.

"A Survey of Relay Test Methods," prepared by the Project Committee on Relay Test Methods, was presented by Sidney Goldsmith of Cincinnati Gas and Electric Company. He reported on the results of a survey conducted among users of protective relay systems.

In "A Transistor Controlled Negative Phase Sequence Alarm Relay" by W. C. Morris and M. E. Hodges of the General Electric Company, Mr. Morris described "the first step toward the use of transistors to meet the expanding requirements of relays." He pointed out the advantages of transistor use, such as electrical versatility and ruggedness. A discussion was presented by G. W. McKenna of Philadelphia Electric Company, in which he complimented the author on his clear, concise explanation of transistor operation.

"Relay Protection of Motors in Steam Power Stations with 4-Kv Grounded Neutral Systems," by W. J. Neff of Ohio Valley Electric Corporation, S. H. Horowitz, of American Gas and Electric Service Corporation, and R. B. Squires of Westinghouse Electric Corporation was presented by Mr. Horowitz. He discussed the many factors involved in choosing the relaying circuits and settings on motors connected to a grounded 4-kv auxiliary bus.

Also presented were "New Thermal Overload Relay with Instantaneous Magnetic Trip on Faults" by W. L. Smith and C. A. Lister of the Electric Controller and Manufacturing Company, and "Application of Low Voltage Switchgear for Motor Control" by E. W. Davis of E. I. du Pont de Nemours and Company (Inc.).

Safety. On Tuesday afternoon, the Committee on Safety had an interesting session, with H. H. Watson, General Electric Company, presiding. The first of five papers, "Electrostatic Explosion Controls in Hospital Operating Rooms," was presented by Robin Beach, Robin Beach Engineers Associated, who said that safety in operating rooms is of serious concern. The safety principles and practices relating to electrostatic explosion hazards as they apply to performance of operating room personnel should be adhered to; for example, slow motion and specialized techniques would permit dissipation of electric charges. Flooring of moderate electrical conductivity in hazardous areas would eliminate electrostatic sparks; a resistance of 0.5 megohms was suggested as a desirable median resistance, and problems of measuring the resistance were discussed.

W. B. Kouwenhoven, Johns Hopkins University, spoke on "Effect of Capacitor Discharges on the Heart." He described an investigation started in 1950 for developing simple effective capacitor discharge equipment for use in bringing the ventricles of a fibrillating heart to rest. About 150 fibrillation experiments were made on dogs, in which it was found that a discharge of 500 joules or more at several thousand volts was required. Charts of test results were shown. N. L. Griffin, U. S. Department of Health, Education, and Welfare, discussed "Emergency Power for Hospitals," as the concept in emergency power designs have changed recently. Three sources of emergency power are acceptable: storage batteries, generators, and second utility line; factors such as service needed, maintenance, cost climate, and local conditions are important considerations. Emergency systems are automatically placed in service in the event of interruption of normal service.

A paper on "Emergency and Exit Lighting in Theaters" was presented by S. R. Todd, who is in charge of the electrical inspection of theaters for the City of Chicago. He discussed the general lighting system features for all areas, and the emergency lighting that is entirely independent and covers all areas, also. If the normal power fails, switches automatically operate to start an emergency system; if this fails, then exit and special emergency lights go on. Auxiliary power is often from a second bank of transformers; 60-cell 120-volt batteries are sometimes used. The last paper, "Throwover Equipment and Unit Equipment for Emergency Lighting," was given by Carl Ippolito, Dual-Lite Company, Inc., who said that many states had laws regarding emergency lighting, while others were contemplating them; thus, engineers and architects will have to specify approved systems. The two basic types of systems are: panic system, to provide illumination for a limited time, as 30 minutes; and an auxiliary system to give power for an indefinite time, not only for illumination, but for fuel systems, elevators, pumps, etc. Zone lighting is required in school gyms and assembly halls. Nickel-cadmium batteries, as well as exit and doorway illumination, were discussed. At the close of the session, questions were asked regarding the frequency of testing theater auxiliary systems, combination battery and generator systems, and special state laws for auxiliary lighting.

Domestic and Commercial Applications. An interesting session, including three paper presentations and a panel discussion, was held Wednesday morning by the Committee on Domestic and Commercial Applications, with B. H. Martin, light department, City of Pasadena, presiding. The first paper, "Service to All-Electric Home," was given by W. R. New, Tennessee Valley Authority (TVA), who pointed out that TVA distribution systems service 155,000, or 12 per cent, all-electric homes, in which all the heat and mechanical energy are supplied through service wires. Electric space heating is now the chief component of the all-electric home. Because of the near unity power factor of the heating load, distribution facilities can carry about twice the kilowatt load of winter heat as of summer air conditioning. The load and temperature data provide information for making a study of the base used in calculating degree-days, a technique of analysis. The second paper by J. C. Beckett, Wesix Electric Heater Company, and C. E. Clifton, Stanford University, was presented by Mr. Beckett, who described

Future AIEE Meetings

South West District Meeting
Baker Hotel, Dallas, Tex.
April 2–4, 1956
(*Final date for submitting papers—closed*)

AIEE-IRE-ISA Magnetic Amplifiers Conference
Syracuse Hotel, Syracuse, N. Y.
April 5–6, 1956
(*Final date for submitting papers—closed*)

Pubber and Plastics Conference
Mayflower Hotel, Akron, Ohio
April 9–10, 1956
(*Final date for submitting papers—closed*)

Great Lakes District Meeting
Hotel Van Orman, Fort Wayne, Ind.
April 16–18, 1956
(*Final date for submitting papers—closed*)

AIEE, ASME, ISA Recording and Controlling Instruments Conference
Bradford Hotel, Boston, Mass.
April 26–27, 1956
(*Final date for submitting papers—closed*)

AIEE-IRE Electronic Material and Component Symposium
Washington, D. C.
May 1–3, 1956
(*Final date for submitting papers—closed*)

North Eastern District Meeting
Sheraton Hotel, Rochester, N. Y.
May 2–4, 1956
(*Final date for submitting papers—closed*)

Seventh Annual Appliance Technical Conference
Wisconsin Hotel, Milwaukee, Wisc.
May 14–15, 1956
(*Final date for submitting papers—closed*)

Summer and Pacific General Meeting
San Francisco, Calif.
June 25–29, 1956
(*Final date for *TP—closed, †CP Syn.—Apr. 10, CPMs—Apr. 20*)

AIEE-IRE-ISA Telemetering Conference
Ambassador Hotel, Los Angeles, Calif.
August 20–21, 1956
(*Final date for *TP—May 20, †CP Syn.—June 5, CPMs—June 15*)

Fall General Meeting
Morrison Hotel, Chicago, Ill.
October 1–5, 1956
(*Final date for *TP—July 3, †CP Syn.—July 19, CPMs—July 27*)

Winter General Meeting
Hotel Statler, New York, N. Y.
January 21–25, 1957
(*Final date for *TP—Oct 24, †CP Syn.—Nov. 8, CPMs—Nov. 16*)

North Eastern District Meeting
Pittsfield, Mass.
May 1–3, 1957
(*Final date for *TP—Feb. 1, ‡DP Syn.—Feb. 15, DPMs—Feb. 25*)

***TP**—Transactions paper
†CPSyn.—Conference Synopsis
CPMs—Conference Manuscript
(The CPSyn. date is 10 days before the CPMs date)
‡DPSyn.—District Synopsis
DPMs—District Manuscript
(The DPSyn. date is 10 days before the DPMS date)

E. R. NEEDLES (*left*) presents the Alfred Noble Prize to R. L. Bright, Westinghouse Electric Corporation; and M. J. Kelly, president of Bell Telephone Laboratories is presented First Prize of the Communications Division by M. D. Hooven (right).

test procedures used with electric heaters of the incandescent type to reduce the microbial content of room air by as much as 50 per cent per hour or better. Results of the test were compared with other purification methods, as ultraviolet radiation, electrostatic air cleaners, etc. Questions were asked regarding volume of air through heater per test period, and temperatures involved. Mr. Beckett, also, presented the third paper, "Trends in Electric Space Heating Controls," and pointed out some of the many advantages of electric space heating and said that control is a dominant factor in its success. He described the use of a master control, in combination with individual room controls for zone heating. He contrasted low-voltage and line-voltage thermostats, and thermostat design and placement for high sensitivity.

The panel discussion on "Electric Space-Heating and Air Conditioning" by J. E. Goff, Ceil-heat, Inc.; R. L. Boyd, Jr., Commercial Controls Corporation; C. F. Kreiser, Edwin L. Wiegand Company; and J. E. Woodward, Union Electric Company of Missouri, brought out a number of technical problems, which face the manufacturers of heating and air-conditioning systems, as well as the many physiological problems, because of the habits of the users. Room-temperature controls should respond to both air temperature and radiant temperature, or they will only approximate a condition of comfort. Electric space heating, either using baseboard heaters of 140 to 200 watts per foot or ceiling heating, has many advantages, including good control. Air-conditioning load is growing very fast, but is converting the residential load from a high power-factor winter peak to a low power-factor summer peak; this is of great importance to distribution engineers because the capacities of almost all elements of an electric system are limited by temperature and, thus, are much lower in summer. The summer load peaks are much broader than the sharp winter peaks, which lowers the thermal capacity of the supply system, and the low power factor of the summer load results in a much greater voltage drop. Many questions were asked regarding improvement of power factor, voltage drops, overloading of transformers, and heat control during the query period.

Radio Communications. Presented at a Wednesday morning session were three papers sponsored by the Committee on Radio Communications Systems, when E. D. Becken of RCA Communications, Inc., presided.

The first, "Design and Application of Ruggedized Traveling Wave Tubes," by A. G. Peifer and W. N. Weber of Federal Telephone and Radio Corporation, was presented by Mr. Peifer. He described usage of these tubes over a 2,000–4,000 mc range and pointed out the advantages which include high bandwidth without a sacrifice in gain. The operating characteristics of the tubes when used as power amplifiers and linear amplifiers were discussed.

H. Havstad of Federal Telecommunication Laboratories presented his paper, "Radial Transmission Line Cavities in Nonsymmetrical Modes." He described some of the results obtained from an investigation of microwave frequency multipliers and amplifiers using radial transmission-line cavities between 200 and 2,700 mc. The application of this novel microwave circuitry in a direct crystal controlled 50-watt peak output AM-pulsed transmitter were also discussed.

In "Standing-Wave Ratio of Inaccessible Load," by Charles Polk of the University of Pennsylvania, formulas were given for the minimum and maximum possible voltage standing-wave ratio of an inaccessible load fed by an imperfect transmission line. The formulas involve measurements at the inaccessible input terminals of the transmission line.

Management of Co-operative Engineering Education Program. On Wednesday morning, four papers were presented about the co-operative engineering educational program which has been in operation for 50 years in American colleges and universities. H. H. Armsby of the U. S. Office of Education defined the program as the integration of classroom and industrial work. He described how the system has been functioning since 1906, when it started with 27 students at the University of Cincinnati, until at present there are more than 13,000 students enrolled in co-operative engineering curricula. On an average, there is one employer for every 5.4 students.

What engineering graduates think of this plan was brought out in the discussions. A graduate of M.I.T. found that his work as an instructor at the University of Maine was greatly helped by his jobs in industry while a student. Another engineer, now with a large utility company, said that he could not have advanced to his present position without having had the industrial experience during his college course. Professor Boehne, who was chairman of the session, stated that Russia is now using the co-operative plan and had 700,000 students enrolled in it.

Marine Transportation. Three papers were presented at the session on marine transportation, Wednesday afternoon. The first, by H. F. Harvey, Jr., and E. J. Dawson, Newport News Shipbuilding and Dry Dock Company, was a report on the use of aluminum for marine switchgear. The first extensive use of aluminum in switchboard construction was in the aircraft carriers *U.S.S. Yorktown* and *U.S.S. Enterprise*. The former carrier was sunk during World War II, but in February 1955 a thorough inspection was made of the *Enterprise's* electrical aluminum equipment; this was found to have withstood the rigors of 17 years' service remarkably well. In order to save weight, the *U.S.S. Ranger*, now under construction, will have all its switchboards and distribution panels made of aluminum.

The use of 400-cycle power on naval vessels was discussed in a paper by J. M. Apple and E. W. Lusby, both of the U. S. Navy. They described the 1,000-volt, 400-cycle equipment now undergoing experiments on the *U.S.S. Timmerman* and some of the findings which have been made to date.

L. M. Goldsmith, Atlantic Refining Company, presented a paper, "Complete Ship Wiring with Mineral Insulated Cable." In order to gain experience with mineral-insulated cable which had been in use in Britain and France for about 20 years, an electrical installation was made in the corrosive atmosphere of an oil refinery, this being considered an even more rigorous condition than on a ship. This installation proved entirely satisfactory over several years' observations, with the result that mineral-insulated cable has been used for all purposes on three 18,700-ton turbine gear driven tankers being built in Belgium. These installations must meet the U.S. Coast Guard regulations and must be in accordance with the AIEE-45 recommendations. These three ships will be put in service in the near future and the author expressed the belief that this type of wiring, new to American shipping, will give years of trouble-free service.

Digital Computers. Five papers were given at the Wednesday afternoon session of the Committee on Computing Devices, at which J. C. McPherson, International Business Machines Corporation, presided. The first paper, "Megacycle Data Processing with Magnetic Amplifiers, Part IV—Core Design," by T. H. Bonn, Fred Bernstein, and D. M. Lipkin, Sperry Rand Corporation, was presented by Mr. Bernstein. The experimental work for designing a core that is smaller, more efficient, made of better materials, and requiring low input power has led to use of thin permalloy magnetic material that has low hysteresis and high-frequency losses, with a high saturation flux density. A figure of merit is established for each material to use in making comparisons. Also, new designs use stainless steel for bob-

bin material, which has distinct advantages over ceramics. Slides were shown of various toroidal windings, and their use in magnetic amplifier circuits. Questions were brought up with regard to fabrication of cores, temperature coefficients, heating at high-frequencies, and potting compounds.

The second paper, "Shifting Counters" was written by C. Eldert, H. J. Gray, Jr., H. M. Gurk, and M. Rubinoff, University of Pennsylvania. Mr. Eldert, who presented the paper, discussed a one-address digital computer with magnetic core memory, which performs the basic operations of addition, comparison, and transfer from arithmetic unit to memory at the rate of one operation every 5 microseconds. There was need for more speed, so by relaxing the restriction that the sequence of addresses follow a true binary sequence, methods are used whereby the instructions in the one-address computer may be sequenced at the pulse repetition rate of the machine. This method offers the advantage of equipment minimization. The next paper, "A Paper Tape Reader Using Germanium Photo Diodes and Transistor Amplifiers," by A. E. Slade and R. D. Potts, was given by Mr. Slade, who described and showed slides of amplifier circuits, one with *P-N-P* transistors used as a switch. He also showed a diode input circuit, which has high gear but poor temperature stability, with current output directly proportional to the voltage, requiring 180 volts to get a current of 3.3 milliamperes. The question of frequency response of the systems was discussed.

The fourth paper, "Cyclic Decimal Codes for Analoque-to-Digital Converters," was given by J. A. O'Brien, Radio Corporation of America, who discussed an encoder in which each measurable angular position of an input shaft is represented by a unique combination of conducting and nonconducting segments, all being connected to a common voltage source. The N independent binary elements can assume 2^n different combinations of states. A systematic investigation of codes was made to optimize the following parameters: readout error, number of encoder brushes, average brush current, number of translator average brush current, and number of translator components. The last paper, "A New Five-Digit Plugboard System of Card-Programmed Calculator," by S. B. Williams and N. M. Noonan, General Electric Company, was presented by Miss Noonan. She described how the design of a 10-digit card-programmed calculator may be altered and optimized for a particular application. In this case, a 5-digit general-purpose floating-decimal plugboard system was developed, which is useful for engineering design calculations. The system is easy to program and easy to check out. The capacity of the calculator has been increased substantially, the memory has been effectively doubled, and the computer speed has been increased by 60 per cent.

Research and Chemical Industry. R. M. Wainwright of the University of Illinois presided at a Wednesday afternoon session sponsored by the AIEE Committee on Research and the Chemical Industry Subcommittee.

The first paper, "Galvanic Fuel Cells" by Friedrich Kornfeil of the U. S. Army Signal Corps Laboratories was presented by Mr. Kornfeil's associate, M. Shapiro, who discussed the various aspects of fuel cell operation. He stated that most difficulties arise from incomplete combustion, from the necessity for removing ash, and from the presence of tar where coal is used. There are reasonable grounds for the belief that a fuel cell with an efficiency superior to the steam cycle may be constructed on a laboratory scale.

In this paper "Nuclear Batteries," William Shorr of the U. S. Army Signal Corps Laboratories described the operation and design of these batteries and listed the characteristics of special significance. There are: continual voltage and current in a compact and portable size; very long life, generally equivalent to the half-life of the radioisotope employed; and operation inherently insensitive to extreme temperature conditions, pressure variations, or strong electric or magnetic fields.

Also presented were "Rectifiers with Impressed Current Anodes," by R. M. Wainwright, University of Illinois; J. P. Oliver, National Carbon Company; and W. A. Luce, Duriron Company; and "Sacrificial Anodes" by Bert Douglas of Dow Chemical Company and H. W. Wahlquist of Ebasco Services, Inc.

Analogue Computer Applications and Developments. E. L. Harder of Westinghouse Electric Corporation presided over a Thursday morning session sponsored by the Computing Devices Committee.

The first of five papers, "A Modern D-C Network Analyzer," by C. H. Hoffman of Public Service Electric and Gas Company and M. Lebenbaum of Airborne Instrument Laboratory, Inc., was presented by Mr. Hoffman. Among the advantages of this analyzer are its low cost and simplicity of operation.

"Linear Programming on an Electronic Computer" by I. B. Pyne of Princeton University presents a method for performing linear programming on an analogue computer containing only standard components.

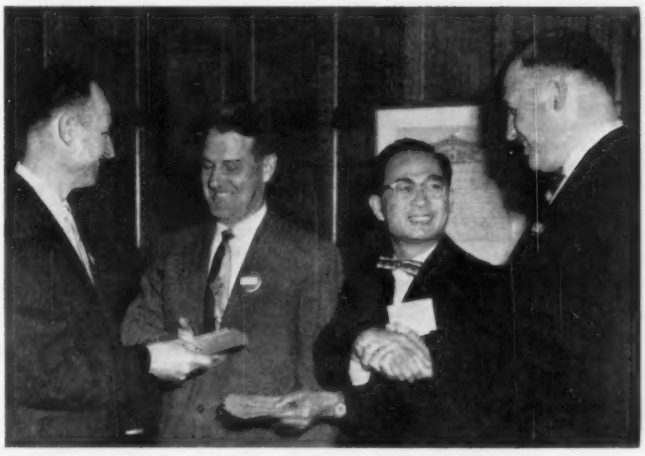
N. D. Diamantides of Goodyear Aircraft Corporation presented his paper, "Analogue Computer Generation of Probability Distributions for Operations Research." He described the use of these computers in predicting and comparing the values, effectiveness, and costs of alternative courses of action involving man-machine systems.

"Electronic Analogue Solution of Free Surface Problems," by W. J. Karplus of the University of California presents a method whereby certain types of free surface problems may be solved rapidly to the desired order of accuracy by means of a combination of a network of resistors and conventional analogue computer units.

The final paper of the session was "Solution of Spherical Polygons by an Electromechanical Analogue Computer" by T. A. Hawkes of the Sperry Gyroscope Company. He described the two techniques used for exact solutions of spherical polygons, the chain-of-resolvers and gimbal-computer techniques. By presenting a typical guided-missile problem, he explained the steps necessary for solution.

Transformers. The Thursday morning session of the Committee on Transformers had five papers presented, with W. C. Sealey, Allis-Chalmers Manufacturing Company, presiding. The first paper, "The Poly-Unit Saturable Reactor," by K. I. Selin, The Royal Institute of Technology (Sweden), was presented by A. Kusko, Massachusetts Institute of Technology. The poly-unit saturable reactor, which has the electrical properties of an adjustable inductance, has an improved load—current wave form.

San Francisco Membership Contest



THE SAN FRANCISCO SECTION'S new member recruitment contest has turned up 45 new applications at the half-way point. Clark Stivers (left), membership committee chairman, presents awards to J. S. Astin, who is leading with 12 applications submitted. Moon Yuen is congratulated by section chairman Whitman Ridgway (right) for following close behind with 11 applications turned in.

The degree of linearity or harmonic distortion of the current is controllable by design. It can be built for single phase or polyphase units, and can operate with good economy in large-power sizes. Connection diagrams and waveforms were shown on slides. The second paper, "Experimental Characteristics of the Three-Phase Poly-Unit Saturable Reactor," by K. I. Selin and A. Kusko, was also presented by Mr. Kusko. He described the design and operating characteristics of an experimental 12-unit 2.7-kva 3-phase poly-unit saturable reactor, which operates with load currents approaching sinusoidal wave forms. The measured harmonic amplitudes are small. Oscillograms of the core fluxes in the 12 cores of the reactor were shown.

The third paper, "A New Apparatus Bushing with Improved Voltage Distribution," was written by L. W. Spooner and J. E. Bergain, General Electric Company. Mr. Spooner, described the high-voltage bushing as a short shielded insulated conductor, with one end terminating in the insulating fluid in the transformer or circuit breaker and with the other end in the air. It has a more uniform control of voltage distribution over the entire insulation provided by an oil-impregnated wrapped paper, plus paper having narrow conducting lines. Three-year field tests have proved its superiority. After two formal discussions, the paper was closed by Mr. Bergain. "Design of the Resistively Loaded Static Frequency Doubler" was then presented by P. P. Biringer, University of Toronto. He described a design which makes use of two calculated points on the load characteristic of the static frequency doubler. The points are the no-load secondary voltage and the secondary short-circuit current, which can be obtained by linear approximation of the *B-H* characteristic of the magnetic core. This permits calculation of peak output power, and relative size of the static frequency doubler at different prescribed regulations. A number of questions were asked the speaker regarding adjustable and larger frequency changers, size of inductor, core and insulating materials, physical layout, and circuit diagrams.

"Proposed Guide for Maintenance of Insulating Oils," was presented by the Insulating Fluids Subcommittee, with C. P. Xenis, chairman, and representatives from transformer groups, oil refinery groups, etc. Questionnaires had been set out regarding maintaining and reclaiming of oils. The proposed guide has nine sections relating to the essential qualities of oil, classification of used oils, oil sampling and testing, reconditioning and reclaiming oils, and addition of inhibitors to oils.

Industrial TV and Broadcast Transmitters. On Thursday afternoon, H. A. Affel of Bell Telephone Laboratories presided at a session sponsored by the Committee on Television and Aural Broadcasting Systems.

"Engineering *ii* (Industrial and Institutional) TV Applications," by J. W. Belcher of General Precision Laboratories, discusses advances in the field of closed-circuit television and describes many of the advantages and applications.

In "A 3-Vidicon Color Television Camera for Live Pickup," L. E. Anderson of the Radio Corporation of America describes a new color camera which, because of its small size and low operating cost, will extend the uses of color television to a large number of applications in education, industry, and broadcasting.

John Christensen and J. J. Reeves of CBS Laboratories presented a paper "Electronic Color Microscope." Following the presentation, an interesting demonstration of the newly developed color-television microscope was given.

The session closed with "A 50-Kw Ampliphase Broadcast Transmitter" by T. J. Boerner of the Radio Corporation of America. He described a system in which the r-f signal is phase modulated by the audio intelligence at a low level and then amplified by high-gain Class C amplifiers to the desired power. The high power phase-modulated signal is then converted to an amplitude-modulated signal by means of a suitable output network.

World Television and Color Television. In a session devoted to television, which was held Thursday morning, three papers were presented. C. J. Hirsch, Hazeltine Laboratories, presented a comparison of the several different television systems throughout the world (page 321 of this issue).

A conference paper by R. C. Kennedy of the National Broadcasting Company entitled "Color Television System Performance Requirements" covered the basic requirements which a transmission system must meet to handle a color-television signal. He illustrated the effects produced by departures from the ideal by various parameters and covered the three broad areas of phase, amplitude, and transient requirements.

The Vitascan method of scanning a scene for live color television as developed by the DuMont engineers was described by J. H. Haines of that company along with G. R. Tingley. With this system, the scene itself is scanned not the image in the camera tube.

Medicine and Biology. In the session on medicine and biology, Friday morning, the first paper was a discussion of radio interference by electronic therapeutic instruments and how they should be shielded so that a minimum of interferring signal would be emitted. H. M. Sachs, Armour Research Foundation, described circuits tending toward interference minimization and the methods of testing.

Saul Aronow, Massachusetts General Hospital, presented a conference paper, "The Use of Radio-Frequency Power in Making Lesions in the Brain." He explained first that lesions were made in certain areas of the brain to isolate them so that they would not register pain from some part of the body which was injured or diseased. After describing the crystal-controlled oscillator and the attendant surgical apparatus and probes inserted in the brain of a patient, he showed how the precise location of the brain area was determined

H. P. Schwan and Kam Li of the University of Pennsylvania presented a report on their findings to date in their research on the health hazards of radar radiations. The two main questions investigated were: how much energy is absorbed by the body; and where is the energy converted to heat? It has been found that high-frequency energy penetrates to different depths in different parts of a body and that the frequency also plays an important part. For instance, from 100 mc up to 10,000 mc, the lower the frequency, the greater is the penetration, and the penetration into fatty tissue is greater than it is into watery tissue.

Electronic Circuits and Systems. H. L. Flowers of the Goodyear Aircraft Corporation presided at a Friday morning session sponsored by the Electronics Committee.

The first paper presented was "A Magnetic Trip Amplifier" by R. B. Hodson and E. W. Manteuffel of General Electric Company, describing the design and use of these devices which are suitable for replacing sensitive relays.

In a paper entitled "Transistor Voltage Regulator" by R. H. Spencer and T. S. Gray of Massachusetts Institute of Technology, Mr. Spencer described a transistor voltage-regulator circuit which takes advantage of the high voltage gain and low emitter resistance exhibited by the junction transistor.

"A Magnetic Voltage and Frequency Regulator for an Aircraft Inverter" by E. W. Manteuffel discussed an extremely accurate device which has been developed to replace a conventional carbon-pile regulator for a 750 volt-ampere, 3-phase, 400-cycle inverter.

In "System Engineering for Guided Missile Installations," Jerome Kraus of the Vitro Laboratories, Silver Spring, Md., pointed out the many complications arising when attempts are made to interconnect systems from different suppliers and the importance of effective co-ordination. He outlined the "systems concept," which consists basically of the application of engineering effort to integrating compatible weapons systems.

"A CW Radar Rate-of-Climb Meter for Vertical-Takeoff Aircraft" by S. H. Logue of the Convair Division of General Dy-

Bimonthly Publications

The bimonthly publications, *Communication and Electronics*, *Applications and Industry*, and *Power Apparatus and Systems*, contain the formally reviewed and approved numbered papers presented at General and District meetings and conferences. The publications are on an annual subscription basis. In consideration of payment of dues, members (exclusive of Student members) may receive one of the three publications; additional publications are offered to members at an annual subscription price of $2.50 each. Nonmembers may subscribe on an advance annual subscription basis of $5.00 each (plus 50 cents for foreign postage payable in advance in New York exchange). Single copies, when available, are $1.00 each. Discounts are allowed to libraries, publishers, and subscription agencies.

Membership in the American Institute of Electrical Engineers, including a subscription to this publication, is open to most electrical engineers. Complete information as to the membership grades, qualifications, and fees may be obtained from Mr. N. S. Hibshman, Secretary, 33 West 39th Street, New York 18, N. Y.

namics Corporation was presented. This paper describes the design and operation of a rate-of-climb meter developed for a compact all-electronic vertical-velocity system.

The final paper presented at the session was "Micropower Operation of Silicon Transistors" by E. Keonjian of General Electric Company, which contains the results of an investigation of the parameters of silicon transistors in the micropower region and in the temperature range from −25 to 75 C. As a result of this study an experimental 2-stage micropower audio amplifier was designed and tested to demonstrate the practical use of silicon transistors at very low power levels.

Computer Devices and Applications. The Committee on Computer Devices had a Friday morning session at which two papers on new computer designs and two on computer application were presented. Morris Rubinoff, University of Pennsylvania, had charge of the session. The paper, "The Radio Corporation of America (RCA) Bizmac Electronic Accounting System," by W. K. Halstead, J. W. Leas, J. N. Marshall, and E. E. Minett, RCA, was given by Mr. Halstead. The Bizmac digital computer, designed for the U. S. Ordnance Tank-Automotive Corporation, is for stock control of automotive parts, and performs the functions of record keeping, calculating, printing records, sorting, and all paper work to save in routine work. It uses a plastic-base magnetic tape with special tape-saving techniques; it records on punched paper tape in code. Charts trace the flow of data through the system, and in various pieces of equipment, including four consoles for manual control. The paper, "Magnetic Tape Handling Equipment in the RCA Bizmac System" by J. A. Brustman, R. E. Montijo, and J. M. Vritis, RCA, was presented by Mr. Montijo, who gave a detailed description of the tape-file assembly, which consists of the various tape stations, tape mechanism, and data storage units. This major part of the Bizmac computer was designed for reliability, tape transport at high speed, maximum service ability, small size, low cost, and adaptability. It uses a unique method of dual-channel recording on tape, 5/8 inch wide, capable of handling 16,000 messages per 2,400 foot tape. Question on the papers were asked regarding plastic versus metal tape, flaws in tape, and tape tension.

The first paper on computer application, "Computer Simulation of a Switching Network" by S. Katz, American Cyanamid Company, concerned a computer for use in sales work, designed by Electro-Data Corporation. It has a large number of inputs to the system, as records of sales, and a small number of outputs. Flow charts showed how a business can be programmed on a computer. The paper, "Automatic Network Analysis with a Digital Computation System," by S. Y. Wong, Philco Corporation, and M. Kochen, Paul Rosenberg Associates, was given by Mr. Wong. As pointed out, a network analyzer is the only practical means for solving large electrical and fluid networks, and very few are equipped with high-speed digital computers for the setting up of problems on them. Once a program for a particular network is constructed, it can be stored in coded form; a master library ensures that many programs are available, so that most commonly encountered network engineering problems can be dealt with in a practical method. One question involved nonlinear system uses.

Industrial Control. J. W. Picking of Reliance Electric and Engineering Company, Cleveland, Ohio, presided at a session Friday afternoon sponsored by the AIEE Committee on Industrial Control.

In presenting a paper "Magnetic Logic Circuits for Industrial Control Systems" by W. G. Evans, W. G. Hall, and R. I. Van Nice of Westinghouse Electric Corporation, Mr. Evans pointed out that as relay control systems become more complex and employ larger numbers of components, the rate of system failures increases. The magnetic logic circuits described provide the desired reliability, and their fast speed of response may make possible the construction of control systems with capabilities beyond those of present relay control systems.

"Overcurrent Protection of Adjustable Speed D-C Motors Operating from Phase-Controlled Rectifiers" by D. R. Kanitz and A. G. Mueller of the Square D Company, Milwaukee, Wis., is a paper which discusses the considerations involved in the installation of these adjustable speed drives. The inadequacy of present nameplate information was stressed. Consideration, it was felt, should be given to the inclusion of additional useful information on nameplates, particularly rms current values.

Also presented at the session were "Proposed Standard for Electronic Motor Controllers" by the AIEE Subcommittee on Electronic Control, and "An Automatic Output Regulator for Power Oscillators" by E. G. Hopkins of New South Wales University of Technology and H. J. Fraser of Amalgamated Wireless Valve Company, Ltd., both in Sydney, Australia.

Wire Communication. At the closing session of the Committee on Wire Communication Systems, Friday afternoon, three papers were given; C. H. McGuire, U. S. Corps of Engineers, presided. "Development of Transcontinental Communications in Canada," by J. W. Noyes, S. Bonneville, and G. Gaudet, Bell Telephone Company of Canada, Ltd., was presented by Mr. Noyes. He spoke about experiences of the Trans-Canada Telephone System in developing a transcontinental telephone network. Canada's five geographical areas present unusual geographical and climatic conditions. Telephone service had been provided by seven isolated telephone systems, with long-distance calls being routed through the United States; in 1929, they formed the Trans-Canada Telephone System. The early system used open wire and type *C* carrier operations; later type *J* carrier was used, with repeaters 35 to 70 miles apart. Each member is responsible for maintenance of plant and equipment in its territory. Future developments include a coast-to-coast radio relay system carrying television and type *L* carrier facilities, scheduled for late 1957. Questions were asked about special line insulation, and types of toll switching.

The second paper, "A New Four-Channel Open-Wire Carrier System Employing Transistors," by R. S. Caruthers, W. S. Chaskin, and H. K. Krengel, Lenkurt Electric Company, Inc. was presented by Mr. Caruthers. He described the carrier system, for use in the 40- to 76-kc range, which makes use of miniature equipment. In the common amplifying, carrier generating, and regulating circuits, transistor circuiting has been employed extensively for the first time in a toll carrier system; including high-gain high-frequency amplifiers with considerable feedback and carrier generating circuits with highly stable quartz crystals. Design of these circuits has been a highly satisfactory experience, and performance results, including regulation, noise, and crosstalk, are excellent. Questions were asked regarding transistor types, manufacturers, and stability.

H. H. Huntley, American Telephone and Telegraph Company, talked on "Objections, Progress, and Promises of Telephone Transmission." Providing service to customers, as well as keeping costs under control, requires three major considerations: instrumentalities, engineering, and maintenance. In the Bell System, 2-million trunk lines, with 90 per cent being under 25 miles, and 30-million circuit loops are in use. Creative thinking in engineering must be applied to prepare for unknown future condition, as well as to take care of present needs. Improvement to trunk equipment is more practical, since carrier and repeater equipment can be used. A discussion followed regarding future use of electronic controlled switching.

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Report of Nominating Committee

The 1956 AIEE Nominating Committee met on January 30, 1956 in New York. There were 19 representatives and 2 alternates present from the list as published in the January issue of *Electrical Engineering*, who selected the following nominees for Institute officers in the administrative year 1956–1957.

For President: Mervin S. Coover, Ames, Iowa.

For Vice-President (two years): District No. 1, Donald E. Garr, Schenectady, N. Y.; District No. 3, Leland F. Stone, Newark,

N. J.; District No. 5, James H. Foote, Jackson, Mich.; District No. 7, Norman F. Rode, College Station, Tex.; District No. 9, Mansfield M. Ewell, Portland, Ore.; District No. 11, Henry H. Kerr, Toledo, Ohio.

For Director (four years): William R. Brownlee, Birmingham, Ala.; Alva A. Johnson, East Pittsburgh, Pa.; Lawrence M. Robertson, Denver, Colo.

For Treasurer: Walter J. Barrett, Newark, N. J.

A. C. Muir of Philadelphia, Pa., representing District No. 2, was chosen chairman of the 1956 Nominating Committee. He presented the report of the Nominating Committee to the General Session of the Winter General Meeting following the conclusion of the committee meeting.

In his report, Mr. Muir spoke of the fact that the Nominating Committee had deliberated long and seriously over the excellent candidates proposed by the Sections and other groups of the Institute for the offices of President and Director. Mr. Muir then reminded the assembly that the Constitution and Bylaws provide for additional nominations by petition as shown in the following.

Constitution: Article VI-33. Independent nominations may be made by petition of 25 or more corporate members sent to the Secretary when and as provided in the Bylaws; such petitions for the nomination of Vice-Presidents shall be signed only by members within the District concerned.

Bylaws: Section 28. Petitions proposing names of candidates as independent nominations for the various offices to be filled at the ensuing election, in accordance with Article VI, Section 33 (Constitution), must be received by the secretary of the Nominating Committee not later than March 25 of each year, to be placed before that committee for the inclusion in the ballot of such candidates as are eligible.

Mr. Muir further reported that the Nominating Committee had selected an Executive Committee authorized to act in the event of an emergency arising prior to the election. This Executive Committee consists of A. C. Muir, chairman; C. T. Hatcher; and S. Reid Warren.

Public Relations Workshop Held for Section Representatives

A PUBLIC RELATIONS WORKSHOP for Section Representatives was held on Tuesday afternoon. The meeting was opened by Fischer Black, chairman of the Public Relations Committee, and he gave a preview of the principles, so that the Section representatives might carry out good AIEE Public Relations.

Attention was drawn to the fact that AIEE activities were both professional and social. The objective or basic philosophy of the Institute, as stated in Article I, Section 2, of the Constitution is the advancement of the theory and practice of electrical engineering and the allied arts and sciences, and the maintenance of a high professional standing. The Public Relations Committee directed its activities toward the students, members of the Institute, business organizations, and the general public; the basic root was considered to be top leadership.

President Hooven addressed the meeting and explained that, like charity, public relations begins at home. Local publicity is just as important as publicity in the New York newspapers, and members are obligated to give their community a correct perspective of the importance of the electrical engineering profession. He urged that false modesty be discarded explaining that engineering was an ancient and honorable profession held in high esteem as stated in the Flexmer Report in 1910, and "one which the medical profession might emulate," inasmuch as every man had to be a college graduate. The lawyers, in an equally frank investigation in 1954, found that only 50 per cent of lawyers were college graduates. Our neighbors and the children in schools should be told that it takes a draft from the upper 15 per cent of the intellectual population to make up the engineering profession. Electrical engineers have been fortunate in that they have made a core around which the other professions evolve, due to the magnetic amplifiers, electronic equipment, relays, and control devices which have been developed. In conclusion, he emphasized the importance of recruiting bright young minds into the electrical engineering profession.

In reference to the Public Relations Council, R. C. Mayer explained that we must have good family relationships in order to have good public relationships; he defined public relationships as doing and telling about good performance, and he enumerated the various channels through which publicity has been released. Experience has indicated that after a general meeting in some locations local meetings have received better publicity. In closing, Mr. Mayer referred to the Publicity Kit, the News Letter, Radio Kit, and invited those in charge of Public Relations to write in and ask questions.

The radio program "Meet the Engineer," sponsored by the Philadelphia Section, on the air for three years, was described by T. H. MacCauley. The time is free, and the objectives of the program are to interest young people in engineering careers, and the importance of building up a high professional standing in the community; it also tells how creative engineering is taught.

The improvement in Public Relations of the Boston section, and the way in which publicity was handled for the Summer General Meeting in Swampscott was described by Svenn Osthagen. The services of a draftsman were enlisted, and poster cartoons were developed, which were distributed to the Boy Scouts and the High Schools; these obtained good results. Meetings were held with the editors to inform them on what AIEE represented. The editors were asked for advice on how to prepare copy and instructed the Public Relations people in what to do. Good results were obtained in this way.

The activities of the Cleveland section to interest high school students in engineering careers, handled through the Cleveland Technical Societies Council, were described by C. J. Beller. Prizes are given, weekly programs are sponsored, and a banquet is

Cleveland Section Honors Fellows

IN DECEMBER, the Cleveland Section held a Fellow Night to honor leading electrical engineers in the northeastern Ohio area. Cleveland Section Fellows in this picture are: (Front row, left to right) R. C. Putnam, Case Institute of Technology; H. L. Wallau, retired; C. J. Beller, Cleveland Electric Illuminating Company; Lanier Greer, Reliance Electric and Engineering Company; C. P. Stocker, Lorain Products Corporation; (Back row, left to right) W. H. Chase, Ohio Bell Telephone Company; W. R. Hough, Reliance Electric and Engineering Company; Floyd Knapp, Ohio Bell Telephone Company; John Leitch, Square D Company; G. A. Kositky, retired; D. Ramadanoff, National Carbon Company; C. W. Fick, retired; G. B. Schneeberger, retired; and E. J. Burger, Ohio Edison Company.

held with funds collected from various industries. Efforts are being made to find summer employment for mathematics and science teachers.

The News Letter of the New York Section, which is mailed to 6,700 members of the section quarterly, with the meeting notices at a cost of $140 was described by V. L. Ingersall and R. T. Higgans, editor. A large number of men, and members with many divergent activities living in distant communities, made the News Letter essential for informational purposes. The letter is printed on 8½-inch by 11-inch sheets in three columns, on both sides.

At the close of the meeting the Eta Kappa Nu film "Engineering a Career" in sound and color was shown to the audience. Fischer Black explained that the film was shown to sell it to the attendance with the possibilities of reshowing in their local sections.

1956 Summer and Pacific General Meeting To Be Held in San Francisco

THE AIEE 1956 Summer and Pacific General Meeting to be held in the Fairmont Hotel in San Francisco June 25–29 offers an excellent technical program and a wide variety of inspection trips. In addition, a full and entertaining program for the ladies, coupled with the unexcelled tourist attractions of northern California and the West provide an ideal opportunity to incorporate a family vacation with a business trip to the convention.

Inspection Trips

I. W. Collins, chairman of the Inspection Trips Committee, announces that plans for tours include the following: the Berkeley campus of the University of California featuring the Radiological Laboratory with its 120-inch Bevatron; the San Francisco Naval Shipyard with the only laboratory in the United States devoted to defense against effects of atomic weapons; San Francisco's new $14 million International Airport and the United Air Lines Maintenance Base; Ames Aeronautical Laboratory at Moffet Field with the world's largest supersonic tunnel for aerodynamic research; the Stanford University Campus featuring a 200-inch linear accelerator and new microscope which peers into the nucleus of the atom; the Westinghouse factory at Sunnyvale and the Ford Motor Company Ford-San Jose assembly plant, including a sightseeing return trip via the East Bay; a boat trip through San Francisco Bay, San Pablo Bay, and Suisun Bay to the Pacific Gas and Electric Company's Pittsburg Steam Plant, offering views of three major bridges, four oil refineries, numerous industrial installations and points of historical interest including the first long span high tension overhead cable crossing over Carquinez Straits.

Ladies Events

Mrs. J. S. Moulton, chairman of the Ladies Entertainment Committee, reports that plans are near completion for a full and interesting program for the ladies attending the convention.

Initial plans include a welcome tea, a fashion show with a Far East theme, a tour of the San Francisco peninsula and famous Roth Gardens, and a tour of San Francisco's Chinatown. Coffee hours, luncheons, and shopping tours are also included. In addition, plans are being made for the ladies to accompany the men on the sight seeing boat trip through San Francisco, San Pablo, and Suisun Bays.

Hotel Reservations

Rooms have been set aside for members and their guests at these hotels: Fairmont (headquarters hotel), $10.50–19; Mark Hopkins, $10–20; Huntington, $8–15; Chancellor, $5.75–8.75; Plaza $9–15; Hillcrest, $4–5.50; Alexander Hamilton (twin beds only), $10–12; Canterbury, $8–10; Cartwright, $7–8; and Cecil, $5–8.50. Rooms will be available in nine other hotels, at prices of from $6 to $10. Plans are under way to reserve rooms in motels in San Francisco. Write for reservations to AIEE Hotels Committee, Box 4588, San Francisco 1, Calif. Include your preference as to hotels, type of accommodations, price range, date of arrival, and mention the 1956 Summer and Pacific General Meeting. Reservations for motels should be so indicated. All reservations will be handled on a first-come first-served basis.

Courtesy of F. J. Kovalcik

GENERAL COMMITTEE and committee chairmen map plans for the 1956 Summer and Pacific General Meeting, June 25–29, San Francisco, Calif. Seated are Vice-Chairman D. I. Anzini and General Chairman J. S. Moulton. Standing (left to right) are W. F. Poynter, treasurer; J. A. Longley, arrangements; W. L. Carter, secretary; I. W. Collins, inspection trips; W. G. Collins, transportation; E. F. Sixtus, registration; and O. A. Gustafson, sports.

Twenty-Third Annual ECPD Report Is Published

The Twenty-Third Annual Report of Engineers' Council for Professional Development (ECPD) has been published following the Annual Meeting of ECPD held in Toronto, Ont., Canada, October 13–14, 1955. The ECPD is a conference of engineering bodies comprised of the AIEE, American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, the Engineering Institute of Canada, American Society for Engineering Education, American Institute of Chemical Engineers, and National Council of State Boards of Engineering Examiners. The Twenty-Third Annual Report contains individual reports of the following committees: Guidance Committee; Education Committee; Student Development Committee; Training Committee; Recognition Committee; Ethics Committee; Information Committee; ECPD-Engineers Joint Council Joint Committee on Practice of Engineering. It also contains Reports of Representatives of the Constituent Organizations. The stated objectives of ECPD are to co-ordinate and promote efforts to attain higher professional standards of education and practice, greater solidarity of the engineering profession, and greater effectiveness in dealing with technical, economic, and social problems. In the educational field, ECPD accomplishes its goal

(Continued p. 378)

Editor's Note: It has been brought to our attention that proper credit was not given for the photograph reproduced in the upper left-hand corner on page 24 of the January 1956 issue of *Electrical Engineering*. This was supplied through the courtesy of the Massachusetts Institute of Technology.

by accrediting curricula leading to degrees in engineering. The newly accredited curricula and the colleges and universities in which they are to be found are listed in the Annual Report.

At the Annual Meeting, unanimous approval was given a recommendation in the form of a resolution that ECPD "sponsor a survey of the engineering professon to include ...all matters pertinent to determine the most effective organization of the profession to meet its public responsibilities and professional opportunities." This resolution is also contained in the Annual Report.

Rubber and Plastics Industries Conference To Be Held April 9–10

On April 9–10, 1956, the Conference on Electrical Engineering Problems in the Rubber and Plastics Industries will be held in the Mayflower Hotel in Akron, Ohio. This conference is sponsored by the Subcommittee on Rubber and Plastics Industries of the General Industry Applications Committee, Industry Division, AIEE.

The tentative program is as follows:

Monday, April 9

9:00 a.m. Opening Session

Keynote Address: W. E. Chope, Industrial Nucleonics Corporation

Cypak, A New Concept in Industrial Control. *P. G. Hanna*, Westinghouse Electric Corporation

Designing Safety into Electrical Controls. *Gregory DiCaudo*, Goodyear Tire and Rubber Company

12:00 Luncheon Recess

2:30 p.m. Afternoon Session

Controlling Fault Currents in Low Voltage Systems. *William Deans*, I-T-E Circuit Breaker Company

Training of Personnel for Maintenance of Electrical and Electronic Equipment. (Panel Discussion) Moderator: *H. W. Roos*, Wallace Clark and Company

6:30 p.m. Banquet

Address: W. S. Wolfe, Goodyear Tire and Rubber Company

Tuesday, April 10

9:00 a.m. Morning Session

Symposium on Problems of Equipment Operating In Contaminated Atmospheres. Committee Chairman: *E. L. Smith*, Firestone Tire and Rubber Company

Silicone Rubber Motor Insulation. *J. L. Kuehlthau*, Allis-Chalmers Manufacturing Company

Irradiated Polyethylene Motor Insulation. *H. E. Mazanek*, General Electric Company

Epoxy Resins for Motor Insulation. *H. L. Lee*, Epoxylite Corporation

Pros and Cons of Standardization. *W. P. Curtis*, Ford Motor Company

11:45 Luncheon Recess

12:00 Subcommittee Meeting

2:30 p.m. Afternoon Session

Requirements of Regulators for Selected Applications. *A. G. Saifried*, B. F. Goodrich Company

New Developments in Dielectric Heating. *W. H. Hickok*, Girdler Corporation

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Nominations for New AIEE Electrical Engineering Education Medal

Nomination Forms for candidates for the new AIEE Medal in the field of Electrical Engineering Education are due at Headquarters, on May 1. This medal, provided from the Members-for-Life Fund, is to be awarded to a teacher of electrical engineering for "excellence in teaching, ability to inspire students to higher achievements, contributions to the teaching of electrical engineering in textbooks and in writings on engineering education, active participation in the work of the professional and educational societies, and contributions to teaching and the profession through research, engineering achievements, and technical papers." (See Electrical Engineering, October 1955, page 937.) The award will be made at the Fall General Meeting in Chicago, October 1–5, 1956.

Nomination Forms should be accompanied by supporting letters from two others who are familiar with the accomplishments of the nominee, one preferably from a former student.

Forms may be procured from E. C. Day, Secretary of the Committee on Members-for-Life Fund, 33 West 39th Street, New York 18, N. Y.

Section Delegates Conference Experiments with Group Dynamics

The Conference of Section Delegates was held on Tuesday morning, January 31, 1956. It was opened by Dixon Lewis, chairman of the Sections Committee, who presided. The secretary of the Sections Committee, R. N. Wagner, gave a brief report of the meeting of the Sections Committee held the previous day, and the remainder of the day was turned over to Dr. T. A. Jackson, director of psychology for the management consultant firm of Stevenson, Jordan and Harrison, Inc.

The remainder of the meeting was conducted on the basis of "Group Dynamics" led by Dr. Jackson, and the participants in each group selected the agenda. The attendance was arranged in three rows so that by turning the seats around in alternate rows groups of six were formed with a chairman appointed for each group. Ten minutes were allowed for the buzz sessions in each group to think up the most important item for the agenda. Each chairman reported a topic, which was explained by the chairman of the Sections Committee, the chairmen of General Committees, or members of the Headquarters Staff.

Among the many items proposed for the agenda were the following topics: "How do sections change their bylaws?"; "What can be done to throw more emphasis on electronics to attract students?"; The progress toward unity; and "Should AIEE have a student publication similar to the IRE?"

In reply to the question as to how sections might change their bylaws, Mr. Lewis referred to Article IX, Section 63 of the Constitution, which permits sections to adopt their own bylaws to be known as "Section Bylaws," provided they are not incompatible with the Constitution of the Bylaws of the Institute. This gives the sections considerable leeway and autonomy. In regard to the question as to what might be done to give more emphasis to electronics in order to attract students, L. M. Robertson suggested that the section meetings should stress electronics more on their program and hold night sessions so that the students could attend.

With reference to the progress of unity, W. B. Morton referred to the article "Struggle for Unity," which appeared in the October 1955 issue of *Electrical Engineering*. A plan was proposed to bring Engineers Joint Council (EJC) and the National Society of Professional Engineers (NSPE) together. The plan which has been presented is under study by the Planning Committee of EJC, and NSPE will publish a section in their magazine about the matter. As to when definite action would be taken depends upon the push and drive people give to it. The Planning Committee has just started a study of the matter which may take six months or a year. Joint meetings have been proposed and the subject has also been under discussion by the EJC Executive Committee.

In regard to the topic of a student publication similar to IRE, W. B. Morton, chairman of the Student Branches Committee explained that a recent poll taken in the branches indicated that 95 per cent of the students did not want a separate publication, but would like a section in *Electrical Engineering* devoted to their activities. It was planned to reprint the 28-page section "In Educational Circles" which appeared in the February issue and distribute this to the various branches.

Presidential nominee, Dr. M. S. Coover addressed the meeting and was impressed by the experiment of "Group Dynamics," which had generated quick active responses. He was also impressed with the interest that was evident in the meeting, and with the fact that changes gave an opportunity to see what was going on in the Institute. In conclusion, he felt sure that progress was being made and that the membership would profit thereby.

At the close of the meeting Dr. Jackson explained that the role of the chairman under "Group Dynamics" was different in that he should have a stiff personality and think about the process, rather than the subject matter. The buzz session was considered the ice breaker.

Institute of Radio Engineers Appoints Its Officers for 1956

The Board of Directors of the IRE, at its January meeting, appointed the following members to the board for 1956: reappointed as treasurer of the IRE was W. R. G. Baker (AM '19, F '47), vice-president of electronics, General Electric Company. Haraden Pratt (AM '15, F '37, Member for Life) was appointed to his fourteenth term as IRE secretary. D. G. Fink (M '45, F '51) director of Research of the Philco Corporation and former editor of *Electronics*, was appointed editor of the IRE. Appointed as directors were A. N. Goldsmith (M '15, F '20, Member for Life) consulting engineer and editor emeritus of the IRE; and J. W. McRae (AM '37, M '50), president of the Sandia Corporation and past president of IRE.

New Honorary Member Urges Unity of Engineers

A plea for unity of the engineering profession was made by J. F. Fairman, vice-president of the Consolidated Edison Company, as honorary membership in the AIEE was conferred on him by M. D. Hooven, president of the Institute. Mr. Fairman's membership, the 43rd bestowed since the society was organized in 1884, was presented at the opening general session of the five-day Winter General Meeting of the Institute in the Hotel Statler.

Much has been said but little has been accomplished toward unifying the engineering profession, said Mr. Fairman, who was president of AIEE in 1949–50.

"In my opinion, based on some 20 years of work and observation in that field," he said, "our principal obstacle is our concern for the mechanics, the form of organization. We exhaust ourselves in fruitless arguments about how to organize to do what needs doing when we should be concentrating our efforts on doing what needs doing. If we could only learn to co-operate in working to attain the important objectives of the profession, I am convinced we would more quickly devise the organization tools needed for more effective accomplishment. We already possess some good organization tools. Let us use them to the full and, by their use, learn how to design and forge better ones. One further caution, let us not waste time debating the objectives, or what we mean by unity. Let us get at the obvious day-to-day problems and let the definitions and the long-range plans evolve from experience. Let us work harder at the grass roots and thereby lay a better foundation for unity at the national level."

In conferring honorary membership on Mr. Fairman, Mr. Hooven pointed out that Mr. Fairman had been a loyal worker in the Institute for 30 years and has held many offices in the Society, in addition to being its representative on United Engineering Trustees, Engineers' Joint Council, and Engineers' Council for Professional Development.

Mr. Fairman is a native of Big Rapids, Mich., and received his bachelor of science in electrical engineering, master of engineering, and honorary doctor of engineering from the University of Michigan. Before joining Brooklyn Edison Company in 1925, he was assistant professor of electrical engineering at his alma mater.

Previous recipients of honorary membership include Lord Kelvin, Cyrus Field, Guglielmo Marconi, Elihu Thomson, Herbert Hoover, Alex Dow, Vannevar Bush, and E. H. Armstrong.

Eta Kappa Nu Recognition Award Dinner

Several hundred members and their guests attended the Eta Kappa Nu Recognition Awards Dinner, January 30, 1956, held in honor of the outstanding young electrical engineers. Preceding the dinner Eta Kappa Nu members inducted Dr. L. N. Brillouin, Dr. W. D. Coolidge and Dr. Harry Nyquist as eminent members of Eta Kappa Nu. President Dr. S. R. Warren, Jr. presided and referred to the original, extremely rare contributions of the eminent members.

Wilbert E. Chope (AM '50) received the recognition award for 1955 "by virtue of his noteworthy achievements in the field of nucleonics and his deep interest in the welfare of his fellow men." His accomplishments were outlined by his brother Henry R. Chope and in response, Wilbert Chope outlined the relationships of "The Engineer in the Business World and Business in the Engineer's World."

Honorable Mentions were awarded to the following four men who were introduced by Dr. J. D. Ryder, vice-president of Eta Kappa Nu: J. N. Grace (AM '52), "by virtue of his outstanding contributions to the development of atomic power and his exceptional activity in civic and professional affairs"; H. R. Johnson, "by virtue of his distinguished research in microwave tubes and his active participation in community organizations"; D. R. Shuster, "by virtue of his notable contributions to the art of anti-aircraft warfare and his wide interests in cultural and social life of his community"; and Glen Wade, "by virtue of his exceptional contributions to microwave research."

The chairman of the Jury of Awards, H. A. Winne, explained that the task of selecting the winners was a difficult one as there were so many good candidates. The Organization Committee, which made the task much easier, was thanked for their work of abstracting the data which enabled the selection of winners to be made in one full day.

In connection with the Coffin Award, Mr. Winne explained that he wanted to see that justice was done and that over 90 per cent of the candidates proposed were unknown to him. He stated that presenting awards was a very serious business if you cared about young people, and that a difficult task had been performed.

Members and guests attending the Eta Kappa Nu Recognition Award Dinner were entertained with an illustrated lecture, "Safari to Africa," given by Dr. W. D. Coolidge.

Seventh Forum of Technical Committee Chairmen

The Forum of Technical Committee Chairmen, intended as an opportunity for a free and open exchange of views, was held on Wednesday evening, February 1, 1956.

The meeting was opened by President Hooven who extended a cordial welcome to the group and complimented them on their work. He stated that the technical activities are part of AIEE's strength and he referred to the expansion of technical activities since the days when the work was guided by the Technical Program Committee. President Hooven explained that the Technical Committees report directly to the Board of Directors and thus they were largely autonomous, with correspondingly great responsibilities. The over-all co-ordination of effort functions through five broad divisions and the Technical Operations Committee.

J. D. Tebo, chairman of the Technical Operations Committee presided during the remainder of the meeting, and emphasized the importance of several operating procedures.

Instrumentation Division. One of the principal matters of interest reported by Dr. Tebo was the announcement that the Technical Operations Committee on recommendation of the Science and Electronics Division approved a petition of the Instruments and Measurements Committee to organize an Instrumentation Division. It has been contemplated that such a division would have committees on indicating and integrating instruments, recording and controlling instruments, electronic and high frequency instruments, special instruments and auxiliary apparatus, telemetering, nucleonics and radiation instruments, and flight test instrumentation. The matter has been referred to the Board of Directors for consideration.

Automation. The chairman of the Industry Division, G. W. Heumann, drew attention to the importance of automation and the fact that the subject cut horizontally across Committee and Technical Division lines. He recommended that AIEE should capitalize on the matter and organize a co-ordinated over-all effort rather than scatter its strength with each committee functioning separately. Mr. Heumann proposed a special technical conference as a first approach, to give the subject prestige, concentrate initial contributions in one place, and simplify obtaining approvals for attendees because of a concentrated program. An early start appeared essential, and the Forum voted that the AIEE should promptly form a joint division committee to sponsor a special technical conference on automation.

Because of printing and mailing schedules Chairman Tebo announced that it would be necessary to advance the closing date for conference papers to be preprinted by the AIEE to 65 days in advance of dates of meetings, instead of 60 days as at present.

Notes on Simulation Conference, Dallas, Texas

Climaxing many months of preparation, the 1956 National Simulation Conference was held in Dallas on January 19–21. The three-day meeting was so well attended that "standing room only" conditions prevailed at some sessions; over 400 persons gathered to hear the 35 technical papers presented at the Texas Room of the Baker Hotel and the auditorium of the Republic National Bank. Representing universities, Government agencies, and industrial concerns of all descriptions, the registrants converged from all parts of the United States, Canada, and England.

The Conference was sponsored by the North Texas Section of the AIEE, the Dallas-Fort Worth Chapter of the Institute of Radio Engineers (IRE) Professional Group on Electronic Computers, the Dallas-Fort Worth Sections of the IRE, together with the Dallas-Fort Worth Chapter of the Association for Computing Machinery. A follow-up of the Cyclone and Typhoon symposia sponsored by the U.S. Navy in New York and Philadelphia in 1951, 1952, and 1953, the National Simulation Conference, 1956, was the first public meeting of national scope specifically devoted to simulation and related computing techniques. It is expected that the Conference will now become an annual affair, in Dallas or elsewhere.

Simulation embraces the use of computers to simulate a system, device, or process (be it electrical, mechanical, chemical, economic, or whatever) by establishing an electronic circuit, for example, which has the same mathematical equations of behavior as the system, device, or process under study. Measurements made on the simulated system are then related to the actual system. Mathematical simulation is the use of the computer purely as an equation solver; the problem may be handled on a slowed or speeded time scale if more convenient than real time. Physical simulation is the use of the computer to take the place of a component or subsystem, not yet fully designed or not yet available, in a test of an over-all system; in this case the computer must operate on real time and its inputs and outputs must be compatible with other elements of the over-all dynamic system.

The technical papers presented at the conference dealt with equipment, techniques, and computer applications in both the mathematical and physical simulation fields; both analogue and digital aspects were included. The range of applications included army tanks, gas turbines, guided missiles, radar, torpedoes, and medicine. Computation equipment emphasis was placed upon the design of function generators, operational amplifiers, and servomechanisms.

All of the papers presented will be published collectively in a "Proceedings" volume; the "Proceedings" can now be ordered from the Conference treasurer, F. W. Tatum, electrical engineering department, Southern Methodist University, Dallas, Tex.

On Friday evening, January 20, 1956, almost 200 of the conference visitors toured the electronic computer facilities, both analogue and digital, of Chance Vought Aircraft, Inc., Dallas, Tex., and Convair, Fort Worth, Tex. Constituting two of the larger electronic computer facilities of the United States, these installation tours afforded the visitors an opportunity to become acquainted firsthand with equipment and techniques in current use.

Nor was the social side neglected at the conference. On Thursday evening, January 19, 1956, a reception was held for conference registrants, their wives, and guests, at the Baker Hotel. At the reception, sponsored by the Western, Eastern, Midwestern, and Southeastern Simulation Councils, informal individual get-togethers were the rule. However, a representative of each council presented a brief description of the activities and plans of his council.

Joint Computer Conference and Exhibit

The Western Joint Computer Conference and Exhibit was held in San Francisco, Calif., February 7–9, 1956. The three-day session was managed by Chairman Oliver Whitby of Stanford Research Institute and keynoted by N. H. Taylor, computer systems engineer with the Lincoln Laboratory, Massachusetts Institute of Technology. Mr. Taylor reviewed the development of the automatic computer industry from infancy to its present early adolescence and then gave some predictions of things to come. Among these was the prediction that within the next 10 years computers will automatically control all transport aircraft with the pilot acting as moderator.

A number of sessions on programming and coding of large-scale scientific and business computers included several papers on automatic programming and supervising systems, emphasizing those techniques which will be helpful in applying computers to business problems. A team of Radio Corporation of America engineers described the new Bizmac computer system which has quite recently been installed for military inventory control.

Novel uses of digital computers as simulators for studying traffic control systems, planning new roadways, and baseball forecasting were described.

Papers on analogue computing techniques included several on combined analogue and digital systems.

Among the papers presenting new advances in hardware were descriptions of auxiliary equipment such as magnetic recording heads, the relatively new Charactron display tube, new magnetic tape handles, and a system for data transmission over telephone circuits. One of the new circuit components described was a device known as the "transfluxor." This can best be explained as a variable setting magnetic gate, instead of the customary devices used in computer design.

Copies of the proceedings will be available through the three sponsoring organizations; the AIEE, the Institute of Radio Engineers, and the Association of Computing Machinery.

Paper and Pulp Industry Conference Held on March 8–9

The AIEE held the Conference on Electrical Engineering as Applied to the Paper and Pulp Industry, on March 8–9, at the University of Florida in Gainesville, Fla. G. I. Burner, chief electrical engineer of The Rust Engineering Company in Pittsburgh was publicity chairman of the AIEE subcommittee on the paper and pulp industry.

The Conference was jointly sponsored by the AIEE subcommittee, the Jacksonville, Fla. Section of AIEE, and the College of Engineering of the University of Florida.

The welcoming address at the opening session was given by Joseph Weil, dean of the University of Florida College of Engineering. In the two days of the Conference, approximately eight papers were presented, and an inspection trip of the University of Florida paper and pulp department was made.

W. B. Tippy Speaks At Michigan Section Meeting

Jackson engineers were hosts to the Michigan Section of the AIEE at a dinner meeting in the First Methodist Church. E. V. Sayles, general engineering supervisor of Consumers Power Company, introduced the speaker of the evening, W. B. Tippy, president of Commonwealth Services, Inc., of New York, N. Y.

Mr. Tippy discussed the future energy requirements of our country and the probable means of meeting these vital future needs. He urged engineers to think beyond present day-to-day energy source patterns and carry forward the attack on problems for which practical solutions must be found in the next 25 to 50 years if the progress of our economy and the steady rise in the standard of living of the people of the United States are to continue unabated.

He further stated that to meet the growing energy needs of the United States, we must find economical ways to supplement coal, oil, and natural gas, today's principal energy sources, as they reach limits of expansion.

Approximately 175 engineers from Jackson and other parts of Michigan attended the meeting.

San Diego Section Holds General Meeting

The San Diego Section of the AIEE held its general meeting "Past Chairman Night" January 17. This very successful meeting was sponsored by the newly formed Management Development Technical Division. The speaker, W. A. Sredenschek, gave a very interesting talk on "Salary Evaluation and Administration."

At the executive committee meeting held prior to the general meeting, Bradley Cozzens, vice-president of the 8th District, explained the results of the consulting firm study made for the AIEE.

The San Diego Section initiated three technical divisions in 1954–55: Aviation, Industrial, and Utility. These divisions were so well received that two additional divisions were started in September 1955. They are Electronics and Management. As a result of these divisions, membership has increased 20 per cent since June 1955; the goal of 25 per cent now seems assured. Because of the new Technical Division, total attendance for all meetings has more than doubled that of last year.

E. F. KOTNIK (*left*) receiving the Past Chairman's Certificate at the San Diego Section general meeting from E. B. Love (*right*).

At this meeting, plans were also announced for a "Membership Month Drive" for February.

The San Diego Section took an active part in Engineers' Week. E. B. Love, chairman of the San Diego Section was vice-chairman of the San Diego Committee for National Engineers' Week.

Great Lakes District Meeting To Be Held April 16–18

THE AIEE GREAT LAKES District Meeting for 1956 will be held April 16–18 at the Van Orman Hotel in Fort Wayne, Ind. Known for its many diversified industries, Fort Wayne is the third largest city in Indiana. An outstanding technical program based upon the future developments in electrical engineering has been arranged. This three-day meeting is complete with a full social program featuring luncheons, buffets, and a dinner-dance. The theme of this meeting, "Engineering Futures Unlimited," is vividly supported by the planned inspection trips.

General Session

The principal speaker, AIEE Past-President T. G. Le Clair, will deliver his address at the opening session Monday, April 16. The Hon. R. M. Meyer, mayor of Fort Wayne, will welcome the membership with C. M. Summers presiding.

Registration

The registration desks will be located in the lobby of the hotel. The facilities for registering will be available Sunday, April 15, from 6 to 9 p.m., Monday and Tuesday, April 16 and 17, 8 a.m. to 2 p.m.

Please return the advance registration card, if possible, as this will enable the registration committee to prepare programs and tickets in advance and, in addition, help facilitate the registration procedure. All fees will be collected upon arrival at the registration desks; therefore, do not enclose remittances with the advance registration.

Buffet Dinner

A buffet style dinner will be held Monday evening, April 16, preceded by an informal get-together cocktail hour. Tickets will be available at $3 each at the registration desk.

Dinner-Dance

The outstanding social event, a dinner-dance, will be held Tuesday, April 17. A social hour will precede the dinner, and there will be dancing from 9 p.m. in the Grand Ballroom. Everett Tinkle and his Orchestra will provide the musical entertainment after dinner. Tickets will be available at the registration desk at $3 each.

Luncheons

Luncheons will be held at 12:15 p.m. each day in the main ballroom. Tickets are $2.25 each. The ladies are cordially invited.

Ladies Events

The ladies who attend the district meeting as guests will have a diversified and interesting program during the convention. A daily coffee hour will offer an opportunity to make plans for the day. Among the scheduled events on Monday is a sightseeing and shopping tour followed by an informal reception. Tuesday will be highlighted by an inspection trip to Station WKJG-TV and a fashion show and tea at Fort Wayne's largest department store, W and D. Tickets for this fashion show will be $1.60 each. On Wednesday an informal coffee and doughnut reception is planned. Ladies are also invited to all of the evening social functions.

Inspection Trips

Four inspection trips are planned to show the latest progress in many engineering fields. Tickets will be furnished at the registration desk. Transportation will be available for all tours. They are as follows:

On Tuesday, April 17 there will be a trip to Phelps Dodge Copper Products Corporation's Inca Manufacturing Division and Indiana Rod and Wire Division, covering the manufacture of magnet wire from raw copper billets to enameled hair-fine magnet wire.

Indiana and Michigan Electric Company which is one of the fastest growing utility companies in the United States. The inspection trip will take us to their Sorenson Station at Roanoke, Ind., built in 1955. This 330-kv station is one of the highest voltage stations in the country and represents part of the American Gas and Electric 330-kv system. The station features a 330-kv compressed air circuit breaker, and the largest 330-kv transformer in existence so far. In addition, the tour will also include a visit to the McKinley Station. This station boasts of the latest type of equipment plus two 50,000-kva synchronous generators.

The General Electric Sound Laboratory will be open for inspection Monday, April 16 and Wednesday, April 18. This sound laboratory was built in 1955 and is reputed to be the best industrial sound laboratory in the country. By using the latest known techniques and materials, they have succeeded in reducing the noise ambient from zero to 10 db. The sound laboratory is capable of testing equipment ranging from oven timers to 10,000-pound transformers.

On Wednesday, April 18, International Harvester Company's Motor Truck Division can be visited. This is one of the largest heavy duty motor truck assembly plants in existence. The tour will enable one to witness the complete assembly of a heavy duty truck.

Hotel Reservations

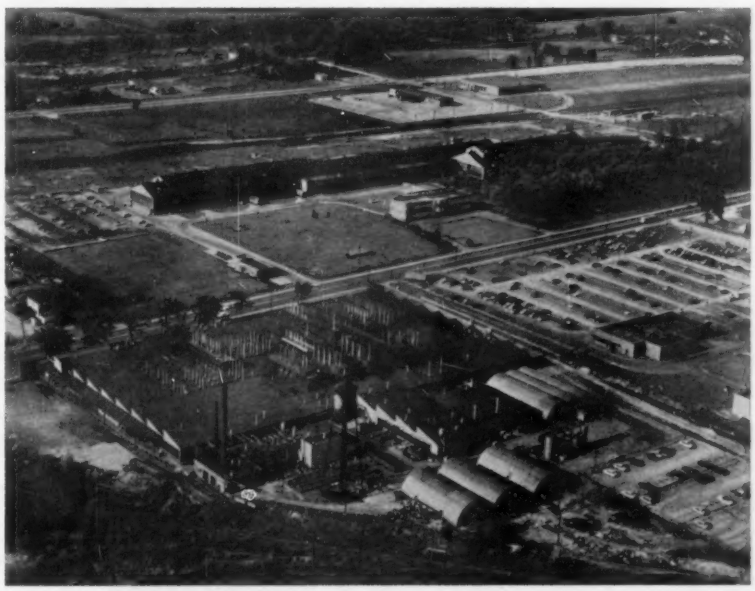
All the arrangements have been made for members and guests at the Van Orman Hotel. Your request for room reservations should be mailed to R. W. Fackler, chairman, hotel reservation committee, Indiana and Michigan Electric Company, 2101 Spy Run, Fort Wayne, Ind. It is suggested that all reservations be made prior to April 1, with plans to arrive on Sunday afternoon or evening, April 15. Hotel prices are as follows at the Van Orman.

Single	$5.50	$8.00
Double	7.00	10.00
Twin	9.50	13.00
Suites	19.00	22.00

Similar prices exist at the other Fort Wayne hotels.

Committee

The Members of the Great Lakes District Meeting Committee are: J. Carroccio, general chairman; C. J. Herman and G. E. Walter, co-chairmen, Technical Program; H. C. Kaeding, Publicity; R. W. Fackler, Registration and Reservation; W. A. Gar-



THE Phelps Dodge Copper Products Corporation plant to which an inspection trip is scheduled during the Great Lakes District Meeting.

vey, Social; D. B. Searls, Inspection Trips and Transportation; A. W. Howard, Finance; H. Wise, Arrangements; Mrs. W. J. Morrill, Ladies: J. H. Capps, Students; R. D. Jones, E. J. Schaefer, W. W. Warner, and S. Winje, Advisory.

Tentative Technical Program of Great Lakes District Meeting

Monday, April 16

9:00 a.m. Registration
10:00 a.m. General Session
2:00 p.m. Magnet Wire and Insulation Materials—I

Presiding: R. W. Hall, Phelps-Dodge Copper Products Corporation

DP. Modern Test Procedures and Equipment for Magnet Wire. *Richard Dermer, John Whitney*, Indiana Technical College; and *Thomas Capin*, Phelps-Dodge Copper Products Corporation

DP. Inorganic Pigment Method for Stack Loss Determination. *F. A. Sattler, F. F. Trunzo*, Westinghouse Electric Corporation

DP. Combination Dacron and Glass for Magnet Wire. *R. W. Hall, R. N. McKnight*, Phelps-Dodge Copper Products Corporation

DP. Magnet Wire Varnish Compatibility. *W. W. Wareham*, General Electric Company

2:00 p.m. Professional Development

Presiding: C. M. Summers, General Electric Company

DP. Industry Views the Electrical Engineering Curriculum. *G. E. Moore*, Westinghouse Electric Corporation

DP. Twice as Much for Your Engineering Manpower Dollar. *A. R. Hellwarth*, Detroit Edison Company

DP. Who Should Be Admitted to the Engineering Colleges. *A. H. Spalding*, Purdue University

DP. The Development of the Role of Engineering Science in Engineering Education. *T. J. Higgins*, University of Wisconsin

2:00 p.m. Power—I

Presiding: W. R. Harris, Westinghouse Electric Corporation

DP. The Westinghouse Nuclear Testing Reactor. *M. A. Schultz*, Westinghouse Electric Corporation

DP. Engineering the Future Power Transformer. *L. W. Schoenig*, Allis-Chalmers Manufacturing Company

DP. Engineering Features of the Super-Fluorescent Street Lighting Installation in Indianapolis. *J. H. Hardy* and *J. H. Smale*, Indianapolis Power and Light Company

56-510 Grounding Grids for High Voltage Stations—III. *E. T. B. Gross*, Illinois Institute of Technology, and *R. S. Hollitch*, Armour Research Foundation

Tuesday, April 17

9:00 a.m. Electronics—I (Design and Research)

Presiding: C. R. Johnson, Farnsworth Electronics Company

DP. New Uses of Ceramics in the Electronic Tube Industry. *H. Huffcut*, Westinghouse Electric Corporation

DP. Glass in Electronics. *W. H. McKnight*, Corning Glass Works

DP. Basic Concepts. *P. T. Farnsworth*, Farnsworth Electronics Company

9:00 a.m. Rotating Machinery—I (Measurement)

Presiding: J. H. Karr, Robbins and Myers, Inc.

56-511 Some Aspects of Surge Comparison Testing of Fractional Horsepower Motors. *R. A. Strain*, Emerson Electric Manufacturing Company

DP56-512 A Speed-Torque Curve Tracer for Motors. *Alex Paalu*, A. O. Smith Corporation

DP. Mechanical Aspects of a Dynamic Speed-Torque Curve Tester. *L. Makous*, A. O. Smith Corporation

DP56-513 A Dynamic Speed-Torque Curve Tracer for Motor Testing and Design. *K. J. Waldschmidt, H. P. Boettcher*, A. O. Smith Corporation

9:00 a.m. Power—II

Presiding: D. P. Dumont, Indiana and Michigan Electric Company

DP. Generation and Transmission of Electric Power—A Forecast. *H. P. St. Clair*, American Gas and Electric Service Corporation

DP. Load Characteristics and Their Effect on Distribution System Design. *H. E. Campbell*, General Electric Company

DP. Effect of Electric Resistance Home Heating Customer Demands on the Distribution System. *V. J. Warnock*, Indiana and Michigan Electric Company

DP. 12 KV—And Then What? *H. L. Hess*, Public Service Company of Indiana

2:00 p.m. Electronics—II (Transistors)

Presiding: R. D. Sinish, Farnsworth Electronics Company

DP. Transistor Operational Amplifier. *G. B. Bush*, Johns Hopkins University

DP. Transistorized Linear Sweep Generators and Precision Amplitude Comparator. *L. C. Merrill*, Farnsworth Electronics Company

DP. A Transistorized Strain Gauge Amplifier. *J. H. Smith*, Texas Instruments, Inc.

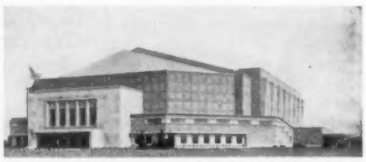
DP. High Frequency Transistor Amplifier. *W. D. Penn*, Texas Instruments, Inc.

2:00 p.m. Transformers and Stationary Equipment—I

Presiding: E. J. Thomas, General Electric Company

DP. Low Noise Level Switching Techniques. *Alexander Finlay*, Battelle Memorial Institute

DP. Temperature Distribution in Electrical Coils. *H. B. Harms*, General Electric Company



THE FORT WAYNE Memorial Coliseum

DP. Application of Digital Computer to Design of Small Transformers. *Glenn Walters*, General Electric Company

DP. Static Switching of Control Circuits. *J. Sheets, W. Alvarez*, General Electric Company

2:00 p.m. Rotating Machinery—II (Design)

Presiding: M. L. Schmidt, General Electric Company

56-514 Calculation of Eddy Current Paths in Drag Cup Induction Motor Rotors. *R. L. Fillmore*, Minneapolis-Honeywell Company

DP. Winding with Controlled Tension. *H. L. Kelley*, Louis-Allis Corporation

DP56-515 Performance Calculations for Part-Winding Starting of Three-Phase Motors. *P. L. Alger*, General Electric Company

DP56-516 Performance Calculation of a Single Phase Induction Motor with Quadrature Auxiliary Winding Connected Across Part of the Main Winding. *F. W. Suhr*, General Electric Company

DP56-517 Switching Transients in Single Phase Induction Motors. *P. V. Rao*, Indian Institute of Science

DP. Measurement of Torque Pulsations During Start of Alternating Current Motors. *M. L. Miller F. H. Wright*, General Electric Company

2:00 p.m. Magnet Wire and Insulation Materials—II

Presiding: H. L. Sauma, Anaconda Wire and Cable Company

DP. Thermal Aging Studies on Insulation Systems for Electrical Machines. *G. L. Moses*, Westinghouse Electric Corporation

DP. Infra-Red Studies of Thermal Aging on Organic High Temperature Films. *A. L. Smith, J. F. Dexter*, Dow-Corning Corporation

VIEW of Fort Wayne, Ind., where Great Lakes Meeting is planned.

DP. Epoxide Resin Coatings for Magnet Wire. *E. L. Smith*, Phelps-Dodge Copper Products Corporation

DP. Compatibility Tests of Enameled Wires in Closed Systems. *W. W. Pendleton, E. H. Olson,* and *H. L. Saums*, Anaconda Wire and Cable Company

DP. D-C Field Coil Testing. *T. J. Gair, C. W. Wallace, Jr.*, General Electric Company

Wednesday, April 18

9:00 a.m. Electronics—III (Testing and Applications)

Presiding: R. E. Collier, Farnsworth Electronics Company

DP. Special Test Equipment. *Donald Ackworth*, Farnsworth Electronics Company

DP. Vibration Isolation Technique. *Kirt Spradlin*, Farnsworth Electronics Company

DP56-518 Rectilinearity of Electron Beam Focusing Fields from Transverse Component Determinations. *P. P. Cioffi*, Bell Telephone Laboratories

DP. Iatron Storage Tube Characteristics. *Dean Davis*, Farnsworth Electronics Company

9:00 a.m. Rotating Machinery—III (Application)

Presiding: E. C. Barnes, Reliance Electric and Engineering Company

DP. New NEMA Frames for Polyphase Induction Motors. *R. J. Dineen*, Allis-Chalmers Manufacturing Company

DP. Planned Discussion on NEMA D-C Re-rating Program. *J. F. Davis*, General Electric Company

DP. New NEMA Industrial D-C Motor. *A. W. Kimball*, Westinghouse Electric Corporation

56-519 Characteristics and Design of 4600 Cycle Alternator. *J. D. McCrumm*, Swarthmore College and Franklin Institute Laboratories for Research and Development

DP. Thermal Protection and Control. *J. Ottmar*, Spencer Thermostat Division, Metals and Controls Corporation

9:00 a.m. Power—III

Presiding: C. R. Lay, Indiana and Michigan Electric Company

DP. A Comparison of 69-KV Transmission Line Construction. *Walter Schulz*, Public Service Company of Indiana

DP. History and Development of the Post Insulator. *Ralph Jenner*, Lapp Insulator Company

56-520 Mathematical Prediction of Radio and Corona Characteristics on Smooth Bundled Conductors Using Smooth Tubes. *C. J. Miller*, Ohio Brass Company

DP. Hot Stick Maintenance of 330 KV. *H. T. Molden*, Indiana and Michigan Electric Company

9:00 a.m. Transformers and Stationary Equipment—II

Presiding: Ordean Kiltie, Ballastran Corporation

DP56-521 Use of Aluminum in Dry-Type Transformers. *B. C. Biega*, General Electric Company

DP. AIEE Test Code for Specialty Transformers. *A. V. Hughes*, Kuhlman Electric Company

DP. Dip Coating for Small Dry-Type Transformers. *R. L. Hamilton*, General Electric Company

2:00 p.m. Rotating Machinery—IV (Application)

Presiding: W. J. Morrill, Morrill Motors

DP56-522 Analysis of the Application of a Torque Motor in a System Where Fast Acceleration and Positioning Are Required. *D. B. Lewins*, Holtzer-Cabot Division, National Pneumatic Company

DP. The Design of Motors for Submersible Operation in Deep Wells. *E. J. Schaefer*, Franklin Electric Company

DP. A Design Engineer's View of Shaded Pole Motor Applications. *J. C. Willsey*, General Electric Company

DP. Design Factors and Problems of Motors for Electric Appliances. *L. C. Packer*, Westinghouse Electric Corporation

DP. Design Progress in General Purpose Fractional Horsepower Motors. *H. L. Wise*, General Electric Company

2:00 p.m. Power—IV

Presiding: G. F. Switzer, Indianapolis Power and Light Company

DP. A New Increased Capacity High-Speed Three-Phase Oil Circuit Recloser. *R. W. Bethke*, Line Material Company

DP. Economics of 13 KV for Highly-Developed 4 KV Urban Areas. *R. P. Huber*, Indianapolis Power and Light Company

DP. Economic Comparison of Secondary Voltages for Residential Areas. *H. E. Lokay*, Westinghouse Electric Corporation

DP. Load Switching's Future—Unlimited. *John Conrad*, S and C Electric Company

2:00 p.m. Transformers and Stationary Equipment—III

Presiding: A. V. Hughes, Kuhlman Electric Company

DP. Magnetic Amplifier Dimming Circuits for Fluorescent Lamps. *H. W. Lord*, General Electric Company

DP. Servo-Positioning for a Non-Glare Headlight System. *Harold Behm*, Battelle Memorial Institute

DP. Fluorescent Lamp Ballast Noise. *R. A. Hutte*, General Electric Company

DP. Noise Evaluation of Luminous Tube Transformers. *L. C. Rademaker*, General Electric Company

North Eastern District Meeting To Be Held at Rochester May 2–4

THE NORTH EASTERN DISTRICT meeting will be held at the Sheraton Hotel in Rochester, N. Y., on Wednesday, May 2–4. A. M. Beebee, president of the Rochester Gas and Electric Corporation, will be the principal speaker. There will be numerous interesting inspection trips to supplement the technical program. For further information of this meeting, refer to the March 1956, Electrical Engineering, page 288.

Following is the tentative program:

Wednesday, May 2

10:30 a.m. General Session

2:00 p.m. Insulators and Insulation

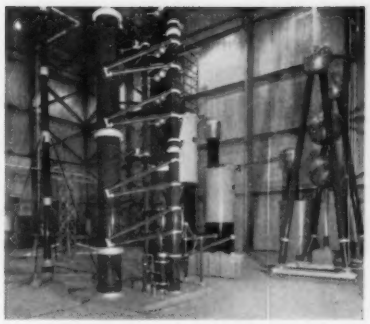
Brent Mills—Presiding

DP. Silco-Flex-New Insulation System for Electrical Rotating Equipment. *J. Kuehlthan*, Allis-Chalmers Manufacturing Company

DP. Corona Studies—In Relation to Insulation. *T. W. Liao*, General Electric Company

DP. Recent Developments in Insulator Manufacture. *D. Alexander*, Victor Insulator Works

DP. The New Lapp High Voltage Laboratory in High Voltage Insulation Design. *J. H. Moran*, Lapp Insulator Company



LAPP INSULATOR COMPANY, one of the largest of its kind in the United States, is offered as an inspection trip for members at the North Eastern District Meeting.

2:00 p.m. Instrumentation

Prof. Charles Dawson—Presiding

DP. Modern Pneumatic—Servo Control Systems—A demonstration of pneumatic components and basic circuits. *G. F. Akins*, Eastman Kodak Company

DP. Digital Control System. *W. M. Brittain*, Westinghouse Electric Corporation

DP. A Sub-Miniature FM Wireless Low-Pressure Differential Telemetering System. *R. Vosteen*, Ossmann Associates

2:00 p.m. Power Line Equipment

W. B. Kenyon—Presiding

DP. Observation of European Electrical Practices. *G. Streeb*, Niagara Mohawk Power Corporation

DP. Auxiliary Equipment for Power Transformers. *Saul Bennon*, Westinghouse Electric Corporation

Thursday, May 3

9:30 a.m. Transformers

H. Eskin—Presiding

DP. Choosing the Power Transformer. *L. W. Schoenig*, Allis-Chalmers Manufacturing Company

DP. Gas and Moisture Equilibriums in Transformer Oil. *R. B. Kaufman, E. J. Shimanski,* and *K. W. McFadyen*, General Electric Company

DP. Magnetization of Transformer Cores During Impulse Testing. *M. F. Beavers, J. E. Holcomb,* and *L. C. Leoni*, General Electric Company

DP. Transformers for High Voltage Power Systems. *C. W. Miller*, Westinghouse Electric Corporation

9:30 a.m. Industrial Applications

S. P. Bartles—Presiding

DP. Electrical Equipment for Machine Tools. *H. L. Lindstrom*, Westinghouse Electric Corporation

DP. An Improved Method of Phase Failure Protection of Electric Motors. *W. Kniel*, Allen Bradley

DP. Current Trends in Modern Vertical Transportation. *H. C. Hickock*, Westinghouse Electric Corporation

DP. Experience in Operating Industrial Distribution Systems Ungrounded. *J. A. Gienger*, Eastman Kodak Company

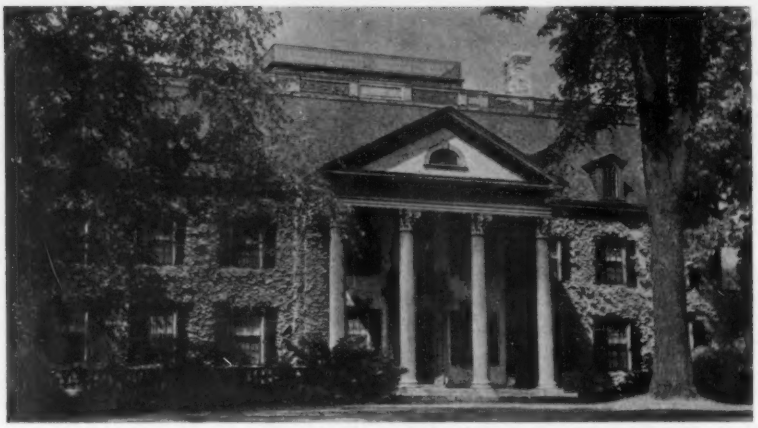
9:30 a.m. Wireless Communication

Don Wilson—Presiding

DP. Design of Electronic Equipment for Radio Interference Reduction. *A. L. Albin, H. M. Sachs*, Armour Research Foundation

DP. A Device to Detect the Minimum Intelligible Signal in the Presence of Noise. *L. M. Harris, J. E. Evans*, Stromberg-Carlson Company

DP. A High Gain Transistorized Video Amplifier. *A. T. Brennan*, Stromberg Carlson company



THE GEORGE EASTMAN HOUSE built in 1905, open to the public as a memorial, is to be visited by members attending the North Eastern District Meeting.

2:00 p.m. Wire Communications

A. V. Dasburg—Presiding

DP. From Telegraphic Dot to Binary Bit. *I. S. Coggeshall*, Western Union Telegraph Company

DP56-582 Modern Trends in the Design of Wire Line Carrier Telephone Equipment. *B. R. Stachiewicz*, Stromberg-Carlson Company

DP. The Synchroscan: A New High-Speed Supervisory System for Railway Signaling. *H. C. Sibley*, General Railway Signal Company

DP. Power Line Carrier Communication for Electrical Utility and Industry Application. *E. A. Sagan*, Westinghouse Electric Corporation

2:00 p.m. Industrial Electronics and Control

John Rodgers—Presiding

DP. The IBM Magnetic Drum Data Processing Machine, Type 650. Engineering and Design Considerations. *E. S. Hughs and R. W. Avery, presented by L. R. Smith*, International Business Machines Corporation.

DP. Repeated Stimulus Generator for Psychological Research. *C. H. Dawson*, University of Rochester

DP. Synchronous Differential Speed Regulator. *S. P. Bartles*, Eastman Kodak Company

DP. Recent Developments in Electrical Measurement and Control of Relative Humidity. *C. E. Ohlheiser*, American Instrument Company

2:00 p.m. Transmission and Distribution

E. K. Nuntington—Presiding

DP. Guiding Principles for Use of Horn Gap Air Break and Load Break Switches for Magnetizing and Network Load Currents on Pennsylvania Power and Light Company System. *W. R. Smith*, Pennsylvania Power and Light Company

DP. Electrical Features of the Upper Raquette River Power Project. *W. C. Van Dyke*, Niagara Mohawk Power Corporation

DP56-583 Loss Reduction from Capacitors Installed on Primary Feeders. *N. M. Neagle, D. R. Samson*, General Electric Company

Friday, May 4

9:30 a.m. Student Prize Papers

C. E. Tuites—Presiding

9:30 a.m. Ethics in Engineering

P. T. Elliott—Presiding

A Panel Discussion. *C. H. Brown, D. E. Garr, H. W. Bibber*

2:00 p.m. Illumination

L. Twitchell—Presiding

DP. High Frequency Operation of Fluorescent Lamps. *A. H. Russell*, Nela Park, General Electric Company

DP. Trends in Fluorescent Lighting—Including Comments on Electroluminescence. *E. F. Lowry*, Sylvania Electric Products, Inc.

DP. Seeing Light and Color. *R. M. Evans*, Eastman Kodak Company

2:00 p.m. Transistors and Semi-Conductors

L. C. Holmes—Presiding

56-584 The Ferro-Resonant Trigger Pair: Analysis and Design. *C. F. Spitzer*, General Electric Company

DP. Semi-Conductor Devices. *R. L. Bright*, Westinghouse Electric Company

DP56-585 The Symmetrical Transistor as a Bilateral Switching Element. *R. B. Trousdale*, Stromberg-Carlson Company

Winter Meeting Papers Now Available

The following is the list of conference papers which were not numbered at the 1956 Winter General Meeting. They have now been numbered and are available to members for 40¢, and to nonmembers for 80¢. Send order and remittance to: AIEE Order Department, 33 West 39th Street, New York 18, N. Y.

CP56-381 Discussion of a New Type Power Transistor. *Joseph Maupin*
298 Partial Transistorization of a Communication Receiver. *G. A. Allard*
431 A Serial Method for Numbering the Slots on a Magnetic Drum. *J. J. Yostpille, A. E. Joel*
335 Corrosion of Line Hardware. *John Eberle*
304 Distribution Systems Practice in Steel Plants. *W. J. Auburn*
297 The Unfinished Business of Engineering Ethics. *P. L. Alger*
310 Effective Salary Administration. *C. J. Beller*
398 Systems Engineering Administration. *J. H. Rubel*
360 Design of a Five-Kilowatt Ceramic Power Tetrode. *F. C. Johnstone*
330 Microwave Applications of Gaseous Discharges. *P. E. Dorney*
366 Modernization of Electrical Equipment on Diesel Electric Locomotives. *W. A. Kirsch*
399 Modernization of Electrical Equipment on Alco Diesel-Electric Locomotives. *J. F. Russell*
301 Modernization During Factory Rebuilding of Diesel-Electric and Electric Locomotives. *K. O. Anderson*
CP56-397 Tests of Intercity Transmission of Teletypesetter Signals at 600 Words Per Minute. *H. A. Rhodes*
359 Transistor-Type Printing Telegraph Transmitter-Distributor. *H. C. Isaacs*
369 Electric Power Distribution in New York's Mammoth Coliseum Building. *H. D. Kurt, L. E. Fisher*
390 Emergency Service for Commercial Buildings. *E. P. Peabody*
327 Application of Low Voltage Switchgear for Motor Control. *E. W. Davis*
395 A Transistor Controlled Negative Phase Sequence Alarm Relay. *W. C. Morris, M. E. Hodges*
333 Economics of Multimillion Watt-Second Inductive Energy Storage. *H. C. Early, B. C. Walker*
379 Effect of Multipath Transmission on Facsimile Signals. *P. R. Marzan*
408 A New Automatic Dispatching System for Electric Power Systems. *B. R. Shepard, D. W. Halfhill, K. N. Burnett*
353 The Charging of Small Particles for Electrostatic Precipitation. *G. W. Hewitt*
337 Proposed Industry Standard for Electrostatic Precipitation Power Supply Equipment. *J. W. Farr, G. R. Monroe*
409 Compatibility in Motor Insulation Systems. *H. R. Sheppard, G. L. Mullen*
410 Evaluation of Modified Silicone Insulation Systems and Motors. *H. R. Sheppard, G. L. Mullen*
317 General Purpose Overhead Distribution—Above 5 Kv. *W. R. Bullard*
326 On the Electric Breakdown of Electronegative Gases. *R. W. Crowe, J. C. Devins*
318 The Effect of Solid Insulation and Contaminants on Gaseous Insulation in Insulation Structures. *G. Camilli, T. W. Liao*
302 Co-operative Education in the United States. *H. H. Armsby—no charge*
428 The Role of Elective Cooperative Programs in Modern Engineering Education. *S. B. Wiltse, E. M. Strong, E. W. Boehne*
357 An Industry View of Cooperative Engineering Education. *H. G. Hutton*
387 Service to All-Electric Home. *W. R. New*
401 Application of Power Rectifiers to Regenerative Drives. *A. Schmidt, Jr., M. M. Morack*
391 Design and Application of Ruggedized Traveling Wave Tubes. *A. G. Peiffer, W. N. Weber*
350 Radial Transmission Line Cavities—Nonsymmetrical Modes. *H. Haystad*
355 Reduction of TV Studio Temperatures Using Heat Control Coatings. *G. T. Howard, A. F. Turner, Carlson and Schroeder*
320 Transformers for Electric Furnaces. *E. F. Christensen, G. Kardseen, Jr.*
407 Problems Associated with Arc Furnace Melting of Copper. *F. D. Shaw*
406 The Effect of Electrode Configuration on the Electric Strength of Hexane. *A. H. Sharbaugh, E. B. Cox, R. W. Crowe, P. L. Auer*
424 The Effect of Hydrostatic Pressure and Applied Voltage Duration on the Breakdown Strength of Insulating Oil. *P. K. Watson*
389 Applied Research in the Italian Power Industry. *Edilio Pavirie*
370 A New Educational Program in Energy Conversion. *A. Kusko, D. C. White*
340 Course Content and Modern Aims in Electrical Engineering Education. *L. A. Finzi, E. R. Schatz*
376 An Explanation of Microwave Fading and Its Correction by Frequency Diversity. *Henry Magnuski*
343 A Low Cost Microwave Radio Communications System. *C. N. Gillespie, D. W. Smith*
339 New Low Cost 960 Mc. Multiplex Radio System. *William Fingerle*
341 Microwave for Telephone Companies. *W. C. Fisher*
361 Engineers in Our Company. *Murray Joslin*
405 On the Dynamic Characteristics of Rectifiers. *Bruce Seddon*
354 TV in World Today. *C. J. Hirsch*
358 Proposed Guide for Maintenance of Insulating Oils. *Insulating Fluids Subcommittee*
386 Evaluation of Thermal Life of Systems. *G. L. Moses*
329 Evaluation of Thermal Life of Materials. *J. F. Dexter*
309 Reduced Insulation in Power Systems—The Problem It Presents. *P. L. Bellaschi*
415 Digital Computers as an Aid in Transformer Design. *G. L. Tauscher*

417 Application of Field Discharge Circuit Breakers to Electrical Machines. *M. Temoshok, D. S. Beall, III*

365 Application of Air Circuit Breakers to Excitation Systems of Salient Pole Synchronous Machines. *C. L. Killgore, H. O. Britt—no charge*

414 Recent Developments in Polyethylene Insulating Materials. *J. A. Snyder, R. J. Lurie*

382 The Dielectric Properties of Polyethylene. *D. W. McCall*

308 Engineering in TV Installations. *J. W. Belcher*

300 A New Color Camera and TV System for Closed Circuit Applications. *L. E. Anderson.*

320 Electron Color Microscope. *John Christensen*

311 A 40 KW Ampliphase Broadcast Transmitter. *T. J. Boerner*

305 Need for Research in the Field of Fuels. *Eugene Ayres*

400 Solar Energy—A Supplementary Energy Source. *H. B. Sargent*

425 The Gas Turbine—A Versatile Servant for the Process Industries. *W. B. Wilson*

325 Automatic Control in the Chemical Industry. *W. A. Crawford*

348 Electricity and Titanium. *W. H. Gorga*

295 A Study of the Co-ordination of Modern Arresters and Transformer Insulation. *E. J. Adolphson, F. J. Vogel*

423 Long Range Heat Aging Tests on Alkanex. *W. W. Wareham*

429 Report of Results of Co-operative Test Program on Test Procedure for Evaluation of the Thermal Stability of Rectangular Magnet Wire. *Working Group Report*

296 Control of Radio Interference from Medical Electronic Equipment. *A. L. Albin, H. M. Sachs*

303 The Use of Radio Frequency Power in Making Lesions in the Brain. *Saul Aronow*

374 A CW Radar Rate-of-Climb Meter for Vertical Take-Off Aircraft. *S. H. Logus*

364 Micropower Operation of Silicon Transistors. *E. Keonjian*

328 System Synthesis with the Aid of Digital Computers. *J. B. Dennis, R. F. Nease, R. M. Saunders*

378 Computive Applications to Induction Motor Design. *W. J. Martiny, Jr.*

373 Relationship Between Corona & Radio Noise on Transmission Lines—Laboratory Studies—Part I—Point and Conductor Corona. *T. W. Liao*

338 Application of Power System Harmonic Filters. *R. W. Ferguson, W. A. Munson*

336 Switching Surges and Continuous Possibilities of Transformer Insulation. *W. C. Farneth, F. J. Vogel*

452 Testing Large Air Circuit Breaker Trip Devices. *C. H. Titus, L. H. Sperow*

380 Evaluation of Insulating Materials in Simple Combinations. *K. N. Mathes*

383 A Fundamental Description of the Mechanical Behavior of Silicone Resins. *J. R. McLoughlin*

356 Objectives, Progress, and Promises of Tele-Transmission. *H. R. Huntley*

375 Three-Dimensional Flight Simulator Supply. *E. P. Longerich*

Electronic Components Symposium To Be Held May 1–3

The 1956 AIEE-IRE Electronic Material and Component Symposium will be held in Washington, D. C., May 1–3. The Roger-Smith Hotel will be meeting headquarters, and the meetings will be held in the Department of Interior auditorium.

The following is a tentative technical program:

Session I

A. W. Rogers, chairman

Opening Remarks and Welcoming Address: A. W. Rogers

Subject not yet determined. *Gen. J. B. Medaris*

More or Better Engineers in Components? *J. D. Ryder*

A Broad Survey of the Military Electronic Equipment Reliability Problem and Its Controling Factors. *C. I. Soucy*, Royal Canadian Air Force, Air Materiel Command, Ottawa, Canada

A Review of Recent British Component Developments. *G. W. A. Dummer*, Radar Research Establishment, Malvern, England, presented by C. E. Richards, G. P. O. Research Station, Dollis Hill, London

Session II—Progress with Materials

G. T. Kohman, chairman

New Glasses and Electrical Components Applications. *W. E. Hauth, A. L. Pugh, Jr.* International Resistance Company, Philadelphia, Pa.

Positive Temperature Coefficient of Resistance Thermistor Materials for Electronic Applications. *H. A. Sauer, S. S. Flaschen*, Bell Telephone Laboratories, Murray Hill, N. J.

Ferrites for Use in S-Band Microwave Components. *H. C. Rothenberg*, General Electric Company, Electronics Park, Syracuse, N. Y.

Properties of Piezoelectric Titanates and Zirconates, Including a Discussion of Their Control and Evaluation. *T. G. Kinsley, R. D. Wehrle*, Sandia Corporation, Sandia Base, Albuquerque, N. Mex.

Glass in High Temperature Components. *W. H. McKnight*, Corning Glass Works, Corning, N. Y.

Standards for Capacitor Paper. *Harvey Anderson*, Western Electric Company, Chicago, Illinois

Session III—Theory and Operating Principles

Gustave Shapiro, chairman

Factors Affecting Back Swing of High Power Pulse Transformers. *Trevor Temple*, Sylvania Electric Products, Inc., Ipswich, Mass.

D-C Current Amplification Factor of Junction Transistors. *Chaang Huang, A. Anouchi*, Sylvania Electric Products, Inc., Woburn, Mass.

The Use of Dispersion Measurements for Analyzing Ceramic Components. *P. N. Russell*, General Electric Company, Electronics Park, Syracuse, N. Y.

Examination of Contact and Other Surfaces by a Plastic Replica Technique. *H. W. Hermance, T. F. Egan*, Bell Telephone Laboratories, Murray Hill, N. J.

Miniature Strip Transmission Line and Transmission Line Components. *J. W. E. Griemsmann, E. N. Torgow*, Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

The Effects of Nuclear Radiation on Electronic Components. *C. C. Robinson*, Wright Air Development Center, Wright-Patterson Air Force Base, Ohio

Session IV—Instrumentation and Measurements

R. H. Baker, chairman

Automatic Testing of Components. *F. C. Booth*, Signals Research and Development Establishment, Christchurch, Hants, England

A Dielectrometer for Millimeter Wavelengths. *M. J. Ehrlich*, Microwave Radiation Company, Gardena, Calif.

Quality Control of Magnetic Sub-Assemblies. *Norton Cushman*, Sprague Electric Company, North Adams, Mass.

High Frequency Transistor Test Set. *C. E. Williams*, Radio Corporation of America, Camden, N. J.

An Automatic Card Punching Transistor Test Set. *M. L. Embree, D. E. Williams*, Bell Telephone Laboratories, Inc., Allentown, Pa.

Magnettor Probe for Traveling Wave Tube Magnetic Field. *V. E. Legg, G. N. Packard*, Bell Telephone Laboratories, Murray Hill, N. J.

Session V—Electron Tubes and Solid State Devices

J. W. E. Griemsmann, chairman

A Report on the State of the Art of Semiconductor Devices. *D. B. Krat*, Radio Corporation of America, Camden, N. J.

High Power Silicon Transistors. *J. S. Saby*, Electronics Laboratory, General Electric Company, Syracuse, N. Y.

Theory of Operation and Application of a New Series of Fixed and Adjustable Corona Discharge Voltage Regulator Tubes. *N. Anton, M. Youdin*, Anton Electronic Laboratories, Brooklyn, N. Y.

The Application of Industrial X-Ray Techniques for the Prevention of Reliable Tube Defects. *E. A. Kolm*, Raytheon Manufacturing Company, Newton, Mass.

Current Trends in Cathode Ray Tube Development and Design. *B. H. Rosen*, Radio Corporation of America, Camden, N. J.

Manufacturing Subminiatures to Meet MIL-E-1B Visual Inspection. *R. E. Brooks*, Radio Corporation of America, Harrison, N. J.

Session VI—Passive Components I

Louis Kahn, chairman

Metal Film Power Resistors. *J. J. Bohrer, W. E. Hauth, Jr., S. J. Stein*, International Resistance Company, Philadelphia, Pa.

Precision and High Temperature Metal Film Resistors. *S. J. Stein, J. Riseman*, International Resistance Company, Philadelphia, Pa.

Pyrolytic Alloy High Temperature Resistors. *C. Wellard, K. Gentner*, International Resistance Company, Philadelphia, Pa.

Wafer Coils for Traveling Wave Tube Solenoids. *A. S. Gutman, A. Babcock, A. Zack*, Sylvania Electric Products, Inc., Ipswich, Mass.

New Type Miniaturized Power Transformers for High Temperature Airborne Applications. *H. S. Feder, A. B. Haines*, Bell Telephone Laboratories, Whippany, N. J.

A New Thermally-Fused Metal-to-Ceramic Volume Resistor. *R. C. Langford, J. Ruckelshaus*, Weston Electrical Instrument Corporation, Newark, N. J.

Session VII—Passive Components II

Leon Podolsky, chairman

High Q Resonant Charging Reactors for Magnetic Radar Pulsers. *C. E. Carter, Jr.*, Westinghouse Electric Corporation, Baltimore, Maryland

Ceramic Transformers and Filters. *C. A. Rosen*, General Electric Company, Electronics Park, Syracuse, N. Y.

Distributed Components in Printed Circuits. *A. Smith, G. Cooper*, Sprague Electric Company, North Adams, Mass.

A New Type of Ferroelectric Shift Register. *J. R. Anderson*, Bell Telephone Laboratories, Inc., Murray Hill, N. J.

Recent Progress in the Development of Standard Functional Divisions for Electronic Equipment. *J. Reeves, R. S. Shultz*, Vitro Laboratories, Silver Springs, Maryland

A Systematic Plan for Predicting Equipment Reliability. *J. A. Connor*, Radio Corporation of America, Camden, N. J.

Reliability Theory and Vital Engineering Interpretations. *H. L. Weurfel*, Radio Corporation of America, Camden, N. J.

COMMITTEE ACTIVITIES

Editor's Note: This department has been created for the convenience of the various AIEE technical committees and will include brief news reports of committee activities. Items for this department, which should be as short as possible, should be forwarded to R. S. Gardner at AIEE Headquarters, 33 West 39th Street, New York 18, N. Y.

General Applications Division

Committee on Marine Transportation (J. E. Jones, *chairman;* J. D. Shuster, *vice-chairman;* W. N. Zippler, *secretary*). Five members of the AIEE Committee on Marine Transportation represented the United States at a conference of Technical Committee No. 18 of the International Electrotechnical Commission at The Hague in Holland last December 6–10. Agreements previously reached at the 1954 conference in Philadelphia, Pa., were extended to include

certain subjects not previously agreed upon. The resulting "Code of International Recommendations concerning Shipboard Electrical Practices," the first edition of which will be issued this year, is expected to form the basis for marine electrical standardization work throughout the world.

The Marine Committee joined with the New York Section, AIEE, in sponsoring a Marine Session at the Winter General Meeting in New York February 1. The session, which presented papers on aluminum switchgear, 400 cycle ship's service power systems, and mineral-insulated cable on shipboard, produced extensive discussion and was well attended.

Continuing its recent practice of spring and fall committee meetings, the Marine Committee will meet in May to consider necessary revisions to AIEE No. 45 "Recommended Practice for Electrical Installations on Shipboard." Matters called to the attention of the committee and acted upon by the appropriate subcommittees will be considered and acted on by the main committee at that time.

Power Division

Committee on Power Generation (F. L. Lawton, *chairman;* J. E. Barkle, *Jr., vice-chairman;* J. H. Kinghorn, *secretary*). An outstanding report "Fire Protection for Generating Stations" has been prepared by the Working Group on Fire Protection in Generating Stations and is currently being reviewed by the Committee on Power Generation. The Working Group has performed an outstanding task in assembling data on generating station fire protection and analyzing the effectiveness of various fire protective means. The report contains specific recommendations for providing the best available fire protection and is now scheduled for presentation to the Institute at the Summer General Meeting in San Francisco.

A problem of mounting importance to the industry is the integration of steam station protective equipment. A working group has been formed to study the protective equipment used in generating stations on all types of equipment. This group will analyze these protective means and provide the industry with the results of their studies. It is possible that some recommended procedures for integrating the station protection may be forthcoming.

A working group of the Hydro-Electric Systems Subcommittee has given extensive study to a proposed questionnaire dealing with factors affecting the performance of thrust bearings in large hydroelectric units. The questionnaire will be submitted to the industry in the hope that it will provide substantial assistance in eliminating many of the thrust bearing problems that have been of some concern during recent years.

Committee on Switchgear (J. D. Wood, *chairman;* J. C. Woods, *vice-chairman;* K. J. C. Falck, *secretary*). All Subcommittees are reviewing the effect, if any, which the proposed new method of rating power circuit breakers may have on the equipment under their jurisdiction. They are also working on additions to their respective Standards to cover capacitance switching.

The urgent need for additional user members on several Subcommittees has been brought to the attention of user representatives at recent meetings and by other means.

Automatic Circuit Reclosers and Automatic Line Sectionalizers Subcommittee. Revisions to Standard No. 50 has been approved by the Committee on Switchgear and submitted to the Standards Committee.

Low Voltage Air Circuit Breaker Subcommittee. The working group on Molded Case Air Circuit Breakers has prepared a draft of a proposed Standard which is expected to be available for consideration by the Committee on Switchgear at its next meeting. The working groups on Calculation of Fault Currents in DC Circuits and Field Circuit Breakers for Synchronous Machines are actively engaged in the preparation of Standards covering these two subjects. As a part of this program a symposium on Field Circuit Breakers was held at the Winter General Meeting in New York. A working group is being established to review AIEE Standard No. 20 for low voltage air circuit breakers to separate the a-c and d-c sections.

Power Circuit Breaker Subcommittee. The proposed new method of rating power circuit breakers is being given a very careful review by an enlarged working group which also is considering other new methods of rating.

Switches, Fuses and Insulators Subcommittee. A revised issue of AIEE Standard No. 22 for air switches, insulator units, and bus supports is being prepared. This issue will include an enlarged test section and also a guide for operation and maintenance of switches and a guide for ice testing. It is also planned to revise Standard No. 25 for fuses above 600 volts to include a revised test section in the very near future. One working group is preparing a Standard for cartridge fuses rated 600 and 250 volts.

Switchgear Assemblies Subcommittee. Several items are considered for inclusion in AIEE Standard No. 27 but since this Standard was only recently made an American Standards Association Standard, no revision will be proposed until of sufficient importance to warrant a reissue.

Science and Electronics Division

Committee on Basic Sciences (W. R. LePage, *chairman;* W. C. Dunlap, Jr., *vice-chairman;* S. B. Batdorf, *secretary*). The chairman of the Applied Mathematics Subcommittee, Michel Malti, departed for India, where he is working on a special project. His duties were assumed by Harry Sohon. Word has also been received of the election of Dr. Malti as a Fellow of the Royal Society. In technical activities, the subcommittee is attempting the inclusion of the field of statistics as a more active area than in the past.

Electric Circuit Theory continued to be the most active subject in the Basic Sciences Committee. This subject alone accounted for the majority of papers published during the year by the Committee in Institute publications.

A special Magnetics conference is planned on this subject for Boston, Mass., in 1956.

A West Coast Subcommittee was inaugurated during the year under the chairmanship of L. J. Lewis. It is expected that this subcommittee will aid greatly in the organization and presentation of Basic Sciences sessions at West Coast meetings.

The year 1955 was also marked by the detachment of the Dielectrics Subcommittee, which has attained the stature of a full committee under the chairmansip of L. J. Berberich.

Another realignment took place during the year with the formation of a Solid-State Devices Committee, in which representatives of the Basic Sciences Committee aided. This committee will assume responsibility for solid-state devices, including semiconductor devices such as rectifiers and transistors. The basic physics and fundamental new developments in semiconductors will continue to fall within the scope of the Subcommittee on Semiconductors and Transistors.

Committee on Computing Devices (E. L. Harder, *chairman;* D. C. Ross, *vice-chairman;* S. H. Dodd, Jr., *secretary*). An international organization has been formed for the purpose of gathering and disseminating information on the design and operation of analogue computers. The organization has been named the "International Association for Analogue Computation" and will have its headquarters in Brussels, Belgium. One of the goals of the Association will be "...publication of a periodical of a high scientific and technical level..."

Association members have suggested that a similar group be formed by specialists in the digital computer field. Anyone wishing further information on this Association should contact one of the members of this Committee. Dr. Harder attended the Brussels conference at which the Association was formed and is a member of its Provisional Committee.

At the Computing Devices Committee Meeting on February 1, 1956, D. C. Ross was appointed by Dr. Harder to represent this Committee in AIEE Standards activities.

The Digital Computer Subcommittee is continuing to work toward obtaining more voluntary papers, and is particularly interested in reviewing papers on simulation and data handling which could be presented at the Pacific General Meeting.

AIEE PERSONALITIES

Nominated for Institute President

M. S. Coover (AM '16, F '42) associate dean, Division of Engineering, Iowa State College, Ames, Iowa, has been nominated as the 1956–57 President of AIEE. He was born in Shippensburg, Pa., on December 9, 1890, and was graduated from Rensselaer Polytechnic Institute with the degree of electrical engineering in 1914. Following a year with the New York Central Railroad and two years with the Montana Power Company he entered the U. S. Army and served in the

M. S. Coover

M. M. Ewell

J. H. Foote

D. E. Garr

H. H. Kerr

AEF. The University of Colorado appointed him instructor in 1919, assistant professor in 1920, associate professor in 1922, and professor in 1930. The Iowa State College appointed him professor and head of the department of electrical engineering in 1935 and associate dean in 1954. In 1942 he was named assistant regional coordinator of the Engineering Science and Management Defense Training Program. From 1942 to 1944 he was Director of the Naval Training School—Electrical at the Iowa State College. At various times during his engineering education career Dean Coover was employed by the General Electric Company, the City of Denver, the Public Service Company of Colorado, and other organizations to conduct special studies. Dean Coover has served on the following AIEE committees: Automatic Stations (1927–29), Sections (1937–46; Chairman, 1940–42), Education (1937–47, 1949–56), Research (1937–40), Planning and Coordination (1940–42), Board of Directors (1940–44, 1955–57), Edison Medal (1941–46, 1955–56), Publication (1944–48), Hertz Award (1944–55), Special Committee on District Boundaries (1944–46), Engineers Council for Professional Development (1945–52), Washington Award Commission (1946–48), Code of Principles of Professional Conduct (1954–56), Lamme Medal (1955–56), Registration of Engineers (1955–56), Transfers (1955–56), and General Applications Division (1955–56). He was secretary, North Central District No. 6 (1929–33) and vice-president, Great Lakes District No. 5 (1944–46). Dean Coover is a member of American Society for Engineering Education, Engineer's Council for Professional Development, Iowa Engineering Society, Engineers Joint Council, National Society of Professional Engineers, Institute of Radio Engineers, Tau Beta Pi, Phi Kappa Phi, Eta Kappa Nu, and Sigma Tau. He was the recipient of the 1938 John Dunlap Memorial Award of the Iowa Engineering Society. He has also worked on several committees for the State of Iowa.

Nominated for Institute Vice-Presidents

M. M. Ewell (AM '38, M '45), engineer, has been nominated as North West District No. 9 Vice-President. He was born in 1898, in Egypt, Wash., and was graduated from the University of Washington in 1924 with the degree of bachelor of science in electrical engineering. He was employed by Westinghouse Electric Corporation at East Pittsburgh, Pa., immediately after graduation and has remained in their employ. After a year on the graduate student course, he joined the central station engineering department and specialized in distribution problems. In 1927, he transferred to the service department in Seattle as a field service engineer. In 1936, he was made manager of the service department in Portland, Ore., where he was responsible for the operation of a repair shop and for the installation and servicing of apparatus built by Westinghouse for use in Oregon and part of Washington. In 1941, he was put in charge of the newly organized engineering and service department in Portland and he holds this position at the present time. Mr. Ewell directs a group of consulting and application engineers, who study the needs of industry in the area, make system studies, and make engineering recommendations as to apparatus to meet requirements, and another group of erection and service engineers, who supervise the installation and servicing of equipment in the field. He has been an active member of the Portland Section of AIEE, serving as chairman in 1948. He served on the National Transformer Committee (1948–50), Committee on Transfers (1952–53, 1954–56), and Committee on Electronic Power Converters (1953–1954). Mr. Ewell is a registered professional engineer in Oregon and is active in the Professional Engineers of Oregon.

J. H. Foote (AM '18, F '32), vice-president, Commonwealth Services, Inc., New York, N. Y., and president and chief engineer in charge of its subsidiary, Commonwealth Associates, Inc., Jackson, Mich., has been nominated for the office of vice-president of the Great Lakes District No. 5. Mr. Foote was born in Jackson, Mich., November 21, 1891, and was graduated from Michigan State College in 1914. Since 1915 he has been associated with affiliated companies now forming Commonwealth Services, Inc. In various capacities he has been responsible for the design and construction of power distribution systems for the Eastern Michigan Power Corporation, Consumers Power Company, Stevens and Wood, Inc., Allied Engineers, and Commonwealth and Southern Corporation, all in Jackson. In 1931 he was made supervising engineer for Commonwealth and Southern, and in 1950 was elected vice-president of its successor, Commonwealth Services, Inc., and president and chief engineer of its engineering subsidiary, Commonwealth Associates. Mr. Foote has served on the board of directors of the American Society for Testing Materials

N. F. Rode

King Studios photo

L. F. Stone

W. R. Brownlee

A. A. Johnson

L. M. Robertson

and on the Standards Council of the American Standards Association. He is a member of the Edison Electric Institute's Electrical Equipment Committee and the Committee on Electric Switching and Switchgear of the Association of Edison Illuminating Companies. He is a registered professional engineer in several states and is active in the affairs of the National Society of Professional Engineers. He is a past president of the Michigan Engineering Society and has served on the Michigan State Board of Registration of Architects, Professional Engineers, and Land Surveyors. He is a member of the American Association for the Advancement of Science, the American Society for Engineering Education, Tau Beta Pi, Eta Kappa Nu, and Pi Tau Sigma. He has served on the following AIEE committees: Power Transmission and Distribution (1929–31); Protective Devices (1932–34); Power Generation (1936–46); Domestic and Commercial Applications (1940–41); Registration of Engineers (1946–56); Standards (1947–50); Insulated Conductors (1947–49); Liaison Representative on the Standards Committee (1951–55); Safety (1954–56); Planning and Co-ordination (1954–56); and Edison Medal (1955–57).

D. E. Garr (AM '37, F '51), manager of the Electrical Engineering Laboratory, General Electric Company, Schenectady, N. Y., has been nominated to serve the Institute as Vice-President representing North Eastern District, No. 1. Mr. Garr was born in Grenola, Kan., on October 23, 1914. He was graduated from Kansas State College in 1936 with a degree of bachelor of science in electrical engineering. He was employed by the General Electric Company in 1936 as a test engineer and successively served as project engineer, assistant division engineer, and division engineer. He is a licensed professional engineer in the State of New York. Mr. Garr is presently serving as secretary of North Eastern District and has served as treasurer and chairman of the Schenectady Section (1950–51). He has served on the Committee on Feedback Control Systems (1949–50) and Sections Committee (1950–51). Mr. Garr was general chairman of the North Eastern District Meeting in 1954.

H. H. Kerr (AM '17, F '44, Member for Life), has been nominated to serve as District 11 Vice-President. Mr. Kerr was born in Fort Worth, Tex., and was graduated from the University of Colorado in 1914 with a bachelor of science degree in electrical engineering. After graduation he spent one year in the test course of the General Electric Company, Schenectady, N. Y. Following this, he spent 14 years with the Public Service Company of Colorado and then transferred to Toledo, Ohio, as superintendent of the electrical operating department of the Toledo Edison Company. He was named general superintendent of engineering operation, maintenance, and construction in 1943; and in 1945 he was appointed vice-president in charge of operations. In 1953 he became vice-president and executive engineer assigned to special problems, a position requiring him to contact the Atomic Power Development Associates, Inc., a group engaged in study leading toward the development of a fast neutron breeder reactor. Mr. Kerr has also been a member of the Toledo Edison Company board of directors for 20 years. He is a member of the American Society of Mechanical Engineers, the Ohio Society of Professional Engineers, and he is currently serving as president of the Engineering Society of Toledo. He received the "Engineer-of-the-Year" award from the Toledo Technical Council, and has been a member of several committees of the Association of Edison Illuminating Companies. He is president and trustee of the Riverside Hospital, Toledo, Ohio, and a trustee of the Toledo Chamber of Commerce. Mr. Kerr served on the AIEE Committee on Electrical Machinery (1942–46).

N. F. Rode (AM '22, F '43), professor of electrical engineering, Agricultural and Mechanical (A and M) College of Texas, has been nominated for Vice-President of South West District 7. He was born in Charleston, S. C., in 1898, and received his bachelor of science in electrical engineering and mechanical engineering from Clemson College in 1919. He has worked for the General Electric, the Chickasaw Shipbuilding, the Isthmian Steamship, and the Sinclair Oil Companies. Since 1922, he has been a member of the teaching staff of the electrical engineering department at Texas A and M College, except for a two-year period in the U. S. Naval Reserve as a Lieutenant Commander teaching electrical engineering at the U. S. Naval Academy. He has done consulting engineering in transmission, distribution, and power plant fields. He is a member of Eta Kappa Nu, Phi Kappa Phi, and Tau Beta Pi, a veteran of both world wars, and a Commander in the U. S. Naval Reserve. He is a professional engineer. He holds advanced degrees from Texas A and M and Clemson College and has been an active member of the American Society for Engineering Education serving as president of the Texas A and M chapter, and elected member to the National Council from the Southwest Section and a member of the Lamme Award Committee of that society. He is also a member of the American Society of University Professors (ASUP) and has been President of the Texas A and M chapter of ASUP. As a research engineer with the Engineering Experiment Station of work Texas A and M College, he has directed work on analogue computers. He has been active in the Institute since his student days at Clemson College, having served as chairman of the Houston Section, chairman of Technical Papers Committee for the 7th Geographical District Meeting in Houston, student counselor at Texas A and M for many years, and chairman of the Student Counselors of the 7th District.

L. F. Stone (AM '23, M '30), senior application engineer, Apparatus Sales Office, General Electric Company, Newark, N. J., has been nominated as vice-president for the New York City District No. 3. Mr. Stone was born in Otter River, Mass., and educated at the Worcester Polytechnic Institute in Worcester, Mass. After graduating with a bachelor of science degree in electrical engineering he went directly to the General Electric testing program in Schenectady, N. Y. After two years, he transferred to the New York office as a field engineer, where he followed the early development of such modern standard equipment as network protectors, gearless elevators, automatic stations, and removable breaker switchgear. Later he served as project engineer on transportation substations, movable bridges, and other public works. After a short time as application engineer in New York, he moved to Newark as an engineer for the apparatus sales office. Mr. Stone holds several patents and is a registered professional engineer in New York and New Jersey. He has served on the AIEE Headquarters Committee (chairman 1954–56) and Sections Committee (1954–56).

Nominated for Institute Directorships

W. R. Brownlee (AM '35, F '51), chief system studies engineer, Southern Services, Inc., Birmingham, Ala., has been nominated to serve on the AIEE Board of Directors. He was born in Cleveland, Tenn., received a bachelor of science degree in electrical engineering from the University of Arizona with highest distinction in 1927, and was granted the professional degree of electrical engineer by Arizona in 1954. Following a year with Westinghouse Electric Corporation, he worked with predecessor or associated companies of the Southern Company System. In 1929, he joined the Tennessee Electric Power Company, beginning with relay engineering and moving into system planning responsibilities. When the Tennessee properties were taken over by the Government in 1939, he transferred to the Jackson, Mich., engineering office of the Commonwealth and Southern Corporation, performing services for the five associated operating companies. When Commonwealth and Southern was dissolved in 1949, he became supervisor of power systems engineering for Commonwealth Associates, Inc., Jackson, Mich., moving to his present position in Birmingham in 1951. Mr. Brownlee is a registered professional engineer, and a member of Tau Beta Pi. He has served on the following Institute Committees: Protective Devices (1937–42, 1946–47), Relays (1947–49, chairman 1947–49), Power Division (1947–55, chairman 1951–53), System Engineering (1949–52), Technical Program (1947–52), Technical Operations (1951–56), Standards (1947–49, 1952–56), Publication (1953–54), Planning and Coordination (1953–56), Prize Awards (1950–52, chairman 1954–56), and Research (1955–56).

A. A. Johnson (AM '32, F '50), engineering manager, Switchgear Division, Westinghouse Electric Corporation, East Pittsburgh, Pa., has been nominated as a candidate for the AIEE Board of Directors. Born July 25, 1909, in Mineral, Va., Mr. Johnson received his degree in electrical engineering from the University of Virginia in 1930. Upon graduation he was employed in the Test Bureau of the Consolidated Edison Company of New York, Inc. From 1936 to 1941 he was in the Outside Plant Bureau at Edison engaged in general engineering planning and technical work. During this same

period, he was active on various committees of the Power Group, New York Section, and he taught evening courses at Pratt Institute. In 1941, Mr. Johnson was employed by Westinghouse as a central station engineer. During the period from 1941 to 1949 he contacted utility and industrial companies in the south and central portions of the United States on application and operating problems of electrical equipment and systems. He was also a lecturer on transmission and distribution for the evening graduate school of the University of Pittsburgh. In 1949, he became manager, electric utility engineering, responsible for general application problems on electrical equipment and power systems throughout the United States. In his present capacity as engineering manager, he is responsible for the development and design of various types of circuit breakers, switchboards, metal clad switchgear, computers, control systems, etc. Mr. Johnson has served AIEE in the following capacities: secretary, Middle Eastern District (1945–47); chairman, Pittsburgh Section (1951–52) and five pre-requisite chairs; Protective Devices Committee (1947–54, chairman 1953–'54); Transformer Committee (1947–54); System Engineering Committee (1947–'50); Power Division Committee (1953–54); Sections Committee (1952–56); Switchgear Committee (1954–56); chairman, Subcommittee No. 7 ASA C42 (1949–56). Mr. Johnson has authored or coauthored a number of AIEE technical papers and has spoken on technical subjects to many AIEE Sections and other technical groups. He is a registered professional engineer in New York and Pennsylvania, a member of American Society of Mechanical Engineers, and a member of Tau Beta Pi.

L. M. Robertson (AM '27, F '45), chief electrical engineer of the Public Service Company of Colorado, has been proposed for Director of the Institute for the 1956–60 term. He has received B.S., E.E., M.S., and Dr. Eng. degrees from the University of Colorado, and the LL.B degree from Westminister Law School. Dr. Robertson is a registered professional engineer, a registered land surveyor, and a member of the Colorado State Board of Examiners for Registration of Professional Engineers and Land Surveyors. He is past president of the Colorado Council of Engineers and a national authority in the electrical utility engineering field, having made many significant technical and administrative contributions to he engineering profession. He has supervised the electrical engineering of some of the largest private power developments in the West, and his ability has been recognized nationally through his work on a number of important committees. He has published more than 35 technical articles in addition to many reports he has made on research and technical committee projects. While president of the Colorado Council of Engineers Dr. Robertson was instrumental in having legislation important to engineers passed by the Colorado legislature. Dr. Robertson's engineering and civic accomplishments have received widespread recognition. In 1954 he received the Gold Medal Award for engineering achievement from the Colorado Engineering Council. In 1955 he received the honorary degree of doctor of engineering from the University of Colorado. His contributions to engineering have extended beyond our own membership through his participation in many other societies including the Conference International des Grands Reseau Electriques of Paris, Edison Electric Institute electric equipment and research projects committees, Professional Engineers Society of Colorado, Colorado Society of Engineers, Colorado Engineering Council, and the Rocky Mountain Electrical League. He is a member of the following fraternities: Tau Beta Pi, Eta Kappa Nu Sigma Delta Kappa, Sigma Tau, and Alpha Tau Omega. For many years, Dor. Robertson has taken an increasingly active part in the technical, operational, and administration phases of the AIEE. He has served as chairman of the Denver Section and vice-president of District 6. He has served on the following AIEE committees: Power Transmission and Distribution (1942–45, 1949–50), Rotating Machinery (1944–47), Education (1945–47), Transmission and Distribution (1945–46, 1948–56), Registration of Engineers (1946–56), Switchgear (1952–54), Sections (1953–56), and Power Generation (1954–56).

Renominated for Institute Treasurer

W. J. Barrett (M '36, F '50), electrical coordination engineer, New Jersey Bell Telephone Company, Newark, N. J., has been renominated to serve the AIEE as Treasurer. Mr. Barrett was born in Brooklyn, N. Y., January 10, 1899, and was graduated from the Polytechnic Institute of Brooklyn in 1920 with the degree of electrical engineer. Upon graduation, he entered the employ of the American Telephone and Telegraph Company, New York, N. Y., and in 1924 was transferred to the staff of the transmission

W. J. Barrett

engineer for the company. In 1930 Mr. Barrett became a supervisor in the engineering department, New Jersey Bell Telephone Company, Newark, and worked on that capacity until his appointment as electrical co-ordination engineer in 1943. Mr. Barrett has been serving as Institute Treasurer since 1953, and has served also as a Director (1949–52), District 3 secretary (1948–49), New York Section secretary and chairman, and on many AIEE committees. Formerly vice-president and chairman of the finance committee of United Engineering Trustees, he is now president. He is also a director of Engineers Joint Council. Mr. Barrett has served on the following Institute committees: Sections (1948–50) Finance (1949–52, Chairman 1950–52) Board of Directors (1949–50, 1954–56), Communication Division (1950–53), Lamme Medal (1950, 1953), Planning and Co-ordination (1950–56), Headquarters (1950–53), Executive (1950–55), Joint AIEE-IRE Coordination Committee (1951–53, Chairman 1953–55), Board of Trustees, and United Engineering Trustees (1951–1956), Board of Examiners (1952–53) and Engineers Joint Council, representative (1954–56).

M. M. Dickinson, Jr. (AM '53) associate engineer of International Business Machines Corporation (IBM), has been appointed Associate Staff Engineer of the Airborne Computer Laboratories of the Military Products Division. A native of Hartford, Conn., Mr. Dickinson received his bachelor of science degree in electrical engineering from the Worcester Polytechnic Institute and has a master of science degree from the Massachusetts Institute of Technology. He came to IBM in June 1952, and is a member of the Institute of Radio Engineers, Sigma Xi, and Tau Beta Pi.

OBITUARIES

Edward Stanley Byng, (M '20, F '29), vice-chairman of Standard Telephones and Cables, Ltd., died at his home in Purley, Surrey, England, at 73 years of age. He was born in Derby in 1883. After graduation from Sheffield University, he joined the National Telephone Company in 1904. Later, he was transferred to London when that system was absorbed by the General Post Office in 1911, he became chief inspector, dealing with plant studies and estimates. In 1913, he became engineer in charge of telephone-cable contracts with the Western Electric Company. During World War I, while on loan to the British Admiralty, he visited the Shetland Islands, Malta, and Corfu as technical advisor on submarine detection. He was transferred to the construction and maintenance section of the European engineering department of the International Western Electric Company in 1921; in 1925 this became the International Standard Electric Corporation. In 1928, Mr. Byng was appointed managing director of Standard Telephones and Cables, becoming vice-chairman in 1935. Mr. Byng was a member of the Institution of Electrical Engineers, and served as treasurer and council member. Among the many papers he contributed to its journal, that on "Telephone Line Work in the United States" received the Fahie Premium. Because of his experience with administrative problems for which no formal training was then available, he became active in the development of such organizations as the Institute of Industrial Administration, Industrial Management Research Association, National Institute of Industrial Psychology, and the British Association for Commercial and Industrial Education. He was a pioneer in demanding the broadest possible education for engineers.

Shirland Jason Kester (AM '43), sales executive for General Electric Corporation, died in Denver, Colo. at the age of 60.

He was born in Meligh, Neb., where he was reared and educated. Mr. Kester was graduated from the University of Nebraska and obtained an engineering degree from the University of Colorado. He had been with General Electric since 1923.

Lloyd Carlton Nicholson (AM '04, Member for Life), retired engineer, died in Orlando, Fla. Born in Richlands, N. C., Mr. Nicholson moved to Orlando 21 years ago from Buffalo, N. Y. He received his bachelor of science degree in 1902 from the University of Missouri, and in 1904–5 he was an assistant professor of electrical engineering there. Between 1905 and 1930 he was associated with the Niagara, Lockport, and Ontario Power Company, Buffalo, N. Y., serving as chief engineer from 1925 to 1930. From 1930 to 1940 he was an independent consulting engineer. He served on the following AIEE committees: Protective Devices (1914–17, 1919–20); Transmission and Distribution (1916–19).

George J. Roewe, (AM '41), electrical engineer at Air Force Headquarters, died at 62. Mr. Roewe first came to Washington in 1936 in the early days of the Rural Electrification Administration (REA). He outlined the specifications under which many early lines were constructed. He was head of the power section when he left the organization in 1942 to become associated with the War Production Board during World War II. Later he served in North Africa with the Foreign Economic Administration, surveying damage done to power plants by the Germans and the possibilities of salvage. After his return from North Africa, Mr. Roewe again was associated with the REA, then with the National Production Authority, and the Potomac River Naval Command. He worked with the Air Force in August, 1955. At the time of his death he was electrical engineer in the maintenance division of USAF headquarters. A native of East St. Louis, Ill., Mr. Roewe attended Tri-State College in Angola, Ind., from which he graduated in 1916 with a degree in electrical engineering. He was distribution engineer with the Carolina Power and Light Company from 1923 to 1936 before joining the REA. He was a member of the Society of Military Engineers.

Joseph B. Swering (AM '35), engineering consultant of The Hartford Steam Boiler Inspection and Insurance Company, died recently. For a number of years, after receiving an electrical engineering degree from South Dakota State College, he was active in electrical construction work, and then engaged in private practice as a consulting engineer. Later, Mr. Swering held supervisory positions in field construction, testing, and servicing, with such firms as the Westinghouse Electric Corporation in East Pittsburgh and Buffalo, N. Y.; the C. W. Roland Company, of Des Moines, Iowa; and the A. H. Savage Company of St. Paul, Minn. For a time he also served on the faculty of the Carnegie Institute of Technology. In 1922, he joined The Hartford Steam Boiler Inspection and Insurance Company, Electrical Division, as assistant chief engineer, from which position he was advanced to chief engineer in 1935. He held the position of engineering consultant at the time of his death, having been appointed in 1954. Mr. Swering was chairman of the Insulation Sub-Committee, Rotating Machinery Committee (1935–41).

Raymond Leo Walsh (AM '49, M '36), retired assistant vice-president and chief engineer of Universal Atlas Cement Company, died after a brief illness at the age of 65. Mr. Walsh, who had been associated for more than 30 years with the cement company, a U. S. Steel Corporation subsidiary, retired on December 31, 1955. He had been importantly connected with the company's engineering and new construction program for many years and upon retirement had been retained by the company in a consulting capacity. A native of Chicago, he was a graduate of electrical engineering at Illinois Institute of Technology. He joined Universal Atlas at Chicago in 1925 as assistant electrical engineer, became electrical engineer in 1929, assistant chief engineer in New York in 1944, chief engineer in 1953, and was appointed assistant vice-president and chief engineer on February 1, 1955, in which capacity he served until his retirement. Mr. Walsh was a member of the Association of Iron and Steel Engineers, and had participated in Portland Cement Association activities, working with the bureau of accident prevention and insurance, as well as on the sub-committee for electrical hazards in quarry operations. He was on the AIEE General Power Applications Committee (1936–38), and Industrial Power Applications Committee (1938–44).

MEMBERSHIP

Recommended for Transfer

The Board of Examiners at its meeting of February 16, 1956, recommended the following members for transfer to the grade of membership indicated. Any objections to these transfers should be filed at once with the secretary of the Institute. A statement of valid reasons for such objections must be furnished and will be treated as confidential.

To Grade of Member

Anthony, L. J., electrical engineer, Western Electric Co., Chicago, Ill.
Bresnick, G. V., assistant engineer, Baltimore Gas & Electric Co., Baltimore, Md.
Buford, W. H., electrical superintendent, Southern Advance Bag & Paper Div., Robert Gair Co., Inc., Hodge, La.
Burmeier, J. C., electrical engineer, Oklahoma Gas & Electric Co., Oklahoma City, Okla.
Carr, R. F., switchgear engineer, Westinghouse Electric Corp., Kansas City, Mo.
Clay, R. E., design supervisor, B. C. Engineering Co., Ltd., Vancouver, B. C., Can.
Conroy, G. J., standards engineer, Radio Corporation of America, Camden, N. J.
Curtiss, L. M., executive engineer, fittings div., The Thomas & Betts Co., Elizabeth, N. J.
David, C. J., transmission engineer, Southern Bell Tel. & Tel. Co., New Orleans, La.
Dolan, A. J., assistant to manager, industry engineering, Westinghouse Electric Corp., East Pittsburgh, Pa.
Fath, D. W., electrical engineer, Cutler-Hammer, Inc., Milwaukee, Wis.
Fellenzer, A. D., Jr., electrical engineer, Rockland Light & Power Co., Middletown, N. Y.
Frankel, T., senior design engineer, Stromberg Carlson Co., Rochester, N. Y.
Frick, R. E., electrical engineer, Gilbert Associates, Inc., Reading, Pa.
Gaines, W. M., engineer, General Electric Co., Schenectady, N. Y.
Geiger, L. F., supervisor-Distribution, Metropolitan Edison Co., Reading, Pa.
Grissler, H. W., senior engineer, Public Service Electric & Gas Co., Newark, N. J.
Heller, F., engineering Manager, Burndy Engineering Co., Norwalk, Conn.
Hively, R. H., supervisor, industrial section, Appalachian Electric Power Co., Charleston, W. Va.
Homsher, J. B., manager, purchasing dept., Gilbert Associates, Inc., Reading, Pa.
Hopkins, D. L., application engineer, General Electric Co., Schenectady, N. Y.
Jalen, H. J., electrical engineer, Electric Controller & Mfg. Co., Cleveland, Ohio.
Kling, W. A., section engineer-system, Central Hudson Gas & Electric Corp., Poughkeepsie, N. Y.
Koehler, R. A., manager, electrical projects, General Electric Co., Schenectady, N. Y.
Lester, J. W., engineer, Ohio Edison Co., Akron, Ohio.
MacDonald, E. H., engineer, Philadelphia Electric Co., Philadelphia, Pa.
Magyar, A. J., substation design engineer, Jersey Central Power & Light Co., Asbury Park, N. J.
Mitchell, F. T., service area engineer, Illinois Power Co., Granite City, Ill.
Murray, J. G., senior engineer, Bettis Plant, Westinghouse Electric Corp., Pittsburgh, Pa.
Oliver, J. B., senior stations engineer, Detroit Edison Co., Detroit, Mich.
Palmer, C. D., electrical engineer, E. I. duPont de-Nemours & Co., Wilmington, Del.
Perez, P. G., electrical engineer, santa eulalia unit, American Smelting & Refining Co., Chihuahua, Chih., Mex.
Pollock, G. D., Jr., chief engineer, Arkansas-Missouri Power Co., Blytheville, Ark.
Robinson, H. S., consulting & application engineer, Westinghouse Electric Corp., San Francisco, Calif.
Roots, W. K., managing director & chief engineer, C. T. Electrical Controls, Ltd., Brandon, Man., Can.
Schaefer, E. H., intermediate engineer, Westinghouse Electric Corp., Pittsburgh, Pa.
Schalck, H. J., electrical engineer, Gilbert Associates, Inc., Reading, Pa.
Schlasman, M. J., division operating superintendent, Metropolitan Edison Co., Reading, Pa.
Schnee, E. O., electrical engineer, USAF, Lake Charles AFB., Lake Charles, La.
Schoenig, L. W., application engineer, Allis-Chalmers Mfg. Co., West Allis, Wis.
Seymour, D. B., consulting & application engineer, Westinghouse Electric Corp., Syracuse, N. Y.
Steele, E. S., electrical engineer, City of Fort Worth, Tex.
Wakefield, K. E., development engineer, laboratory, General Electric Co., Schenectady, N. Y.
Wappler, D., senior engineer, Public Service Electric & Gas Co., Newark, N. J.
Weiss, C. S., district engineer, Southern Bell Tel. & Tel. Co., Anniston, Ala.
Welch, C. M., supervisory electronic engineer, U.S. Signal Corps Agency, White Sands Proving Ground New Mex.
Wieseman, T. R., vice president, The Louis Allis Co., Milwaukee, Wis.

47 to grade of Member

Applications for Election

Applications for admission or re-election to Institute membership in the grade of Member, have been received from the following candidates, and any member objecting to election should so notify the Secretary before April 25, 1956, or May 25, 1956, if the applicant resides outside of the United States, Canada, or Mexico.

To Grade of Member

Abou-Taleb, N. M., Newark College of Engg., Newark, N. J.
Albertson, F. W., Dow, Lohnes & Albertson, Washington, D. C.
Beno, J. H., Hughes Aircraft Co., Culver City, Calif.
Billings, S. M., General Elec. Co., W. Lynn, Mass.
Boobyer, E. F., Kaiser Aluminum & Chemical Corp., Oakland, Calif.
Chameides, M., City College of New York, New York, N. Y.
Dearden, A. R., U. S. Air Force Base., Goose Bay, Labrador, Canada.
Easterlin, P. R., Western Union Telegraph Co., New York, N. Y.
Gallaher, C. A., The Stearns-Roger Mfg. Co., Denver, Colo.
Goldberg, H., Public Service Co. of Indiana Inc., Plainfield, Ind.
Hessler, O. G., Sears, Roebuck & Co., Chicago, Ill.
Holmes, A. W., Govt. of Canada, Dept. of Public Works, Toronto, Ont., Canada.
Junor, W. R., Mayor & Town Council, New Amsterdam, Berbice, B. G., S. A.
King, R. O., Green Mountain Power Corp., Montpelier, Vermont.
Kotter, F. R., National Bureau of Standards, Washington, D. C.
Kraay, R. A., Western Electric Co., Chicago, Ill.
Lee, C. P., Bechtel Corp., Oakland, Calif.
MacHill, J., General Elec. Co., Auburn, N. Y.
Meron, E., Automatic Elec. Corp., Chicago, Ill.
Monaco, W. J., Sanderson & Porter, New York, N. Y.
Morison, J. W., Electricity Authority of Cyprus, Nicosia, Cyprus.
Pheeroze Neemuchwala, N., Swat Textile Mills Ltd., Karachi, Pakistan.
Pringle, J. T., Bechtel Corp., San Francisco, Calif.
Ross, D. K., 7908 Bonhomme, St. Louis, Mo.
Sargent, J. A., Beemster Electric Co., Green Bay, Wisconsin.
Thurston, R. S., The Kelek Co., Norwood, Mass.
Vardanian, G., Corps of Engineers, Casablanca, Morocco.

27 to grade of Member

NEWS IN THE COLLEGES

The Administrative Details of an AIEE Student Branch

THIS ARTICLE was written by G. V. Lago who is an AIEE Member, and on the Committee on Student Branches.

A major problem encountered by all Student Branches is the lack of student time. Classes, laboratories, the writing of laboratory reports, and study crowd the day of the normal engineering student and leave him only limited time for assuming duties connected with outside activities. Consequently the more carefully a Student Branch is organized, the more quickly the actual details of administration can be performed, thus leaving the student officers more time for planning actual program content and for carrying out other projects.

It is not the purpose of this article to discuss the value and importance of the AIEE student program. These are already well established. Rather, this article describes the administrative details that have been worked out by the Student Branch at the University of Missouri. Although this article is written from the point of view of one Student Branch, it is hoped that much of this material may prove to be of value to other Student Branches when adapted to local needs.

One of the first concerns of any Student Branch at the beginning of each school year is the membership drive. At the University of Missouri, the following procedure has proved helpful. Early in the first semester, preferably during the first week, representatives of the membership committee of the Joint AIEE-IRE Student Branch enter classrooms where all electrical engineering students can be contacted. These spokesmen explain the purpose, the program, the local and national dues, and other matters pertaining to the Student Branch. Simultaneously, a membership table is set up in the hallway and manned by the membership committee for the major portion of each day for approximately a week. The following materials are made available:

1. Application blanks for both AIEE and IRE national organizations.
2. Information blanks for the local chapter. In addition to the usual questions about name, address, and class, these blanks request the student to state the types of meetings he desires, the committees on which he prefers to serve, and his comments on the operation of the Branch in the previous year. A careful effort is made to analyze these statements in order to improve the general quality of the programs, as well as to give the student expressing interest in a certain committee an opportunity to become a part of the Branch through active participation in its activities.
3. Local membership cards. As soon as the student pays his local dues he is presented with a printed membership card. This is in itself a small thing, but student reaction to it has been both favorable and pronounced. The card is proof that he is a member in good standing.
4. Blank postal cards. At the time of registration the student is asked to address postal cards to himself, four cards for each semester for which he has paid his dues. Approximately one week before meeting time, a description of the next meeting is mimeographed on a set of these cards and they are then mailed, thus saving many hours of time that might otherwise be devoted to addressing meeting notices.

In the second week of the semester, the approach is shifted to a more personal level. Lists are compiled of names of all students not yet members of the organization. The membership committee then divides these lists and each nonmember is contacted and asked to join the Local Branch and to become a National Student Member.

Another technique that has proved helpful is a system of delegated responsibilities. This consists of tabulating the responsibilities of each officer. The schedule is given to officers immediately after the election meeting. Thus, the new officers begin with a clear picture of the duties expected of them.

At the beginning of each executive council meeting the chairman reads through this schedule, asking each officer whether he has performed his assigned duties. After the run-through of the schedule, untabulated monthly business is considered. Before the executive committee meeting is dismissed, an attempt is made to reach a definite decision on each item of new business and in the

University of Alabama Branch Activities

MEMBERS OF THE UNIVERSITY OF ALABAMA Branch of the AIEE at the January meeting. Student officers and faculty are seated in the first row. The Alabama Section of the AIEE co-operates very effectively with the University of Alabama Branch. Approximately 15 members of the Section visited the Branch and presented the program for the Branch at its December meeting. E. C. Gaston, vice-president of Southern Services, Inc., was the principal speaker. The Student Branch Co-operation Committee of the Alabama Section also arranged a December inspection trip for the students to the American Brake Shoe plant at Calera, Ala., and the Westinghouse Welding Rod plant at Montevallo, Ala.

In February, the students met with the Section at its monthly meeting in Birmingham where a special program was presented for the students.

case of an affirmative vote to assign definite responsibility for its execution; a date is set for a report or for completion of the job.

Some of the duties mentioned appear in the following schedule. As mentioned before, other branches will have to adapt this schedule to their local needs.

General Rule

The Executive Council shall meet one week before each regular meeting.

Chairman

1. Presides at Executive Council meetings and at regular monthly meetings.
2. Checks up on other officers to see whether they are carrying out their assigned duties listed below.

Vice-Chairman

1. Acts as chairman in case of his absence.
2. Writes letters of thanks to each speaker or to others who have helped the organization.
3. Acts as assistant to the chairman in carrying out organizational activities.

Membership Chairman

1. Organizes membership drive at the beginning of each semester. When students join, be sure that they:
   (a) Fill out national blanks.
   (b) Fill out local blanks.
   (c) Receive local membership cards.
   (d) Address four postal cards to themselves for each semester of membership.
2. In connection with the above, organizes and runs membership table in the hall.
3. Compiles list of nonmembers.
   (a) Contacts all seniors, juniors, sophomores, and freshmen if possible.
   (b) Has active members personally contact nonmembers and invite them to meetings.
4. Works with publicity chairman on posters.

Treasurer

1. Collects dues.
2. Pays all debts.
3. Keeps record of paid members.
4. Sends to national headquarters for rebate.
5. Assists program and membership chairmen.

Program Chairman

1. Arranges the Career Seminar panel discussion meeting in co-operation with the St. Louis Section of the AIEE.
2. Arranges movie sessions.
3. Arranges other regular meetings.
4. Arranges student paper meeting.
5. Arranges inspection trips.
6. Arranges social activities.
   (a) Fall open house.
   (b) Spring picnic.
7. Arranges dinner at hotel or restaurant with speaker before each meeting.
   (a) Contacts place of dinner in advance.
   (b) Has as many as possible of the Branch officers attending dinner.
   (c) Invites all students and faculty to attend dinner.
      (1) Announces at previous meeting.
      (2) Makes reservations in advance.
8. Contacts speakers approximately six weeks in advance.
9. Reserves room for each meeting.

Recording Secretary

1. Records and reads minutes of all general and executive meetings.
2. Submits a copy of the minutes to both the AIEE and IRE corresponding secretaries on the day after each general meeting.
3. At the beginning of each semester prepares and submits a list of members to the director of affairs for men.

AIEE Secretary

1. Keeps adequate supply of national AIEE blanks.
2. Has stationary made.
3. Keeps and maintains membership records.
4. Sends copies of meeting reports on standard forms to:
   (a) N. S. Hibshman, secretary, AIEE.
   (b) National Chairman of Committee on Student Branches.
   (c) Vice-President of the District.
   (d) District Chairman of Student Activities.
5. Sends in national dues.

IRE Secretary

1. Keeps adequate supply of national IRE blanks.
2. Has stationery made.
3. Sends copies of minutes of each meeting to national headquarters.
4. Keeps and maintains membership records.
5. Sends in national dues.

Publicity Chairman

1. Makes general membership posters and puts them up at the beginning of each semester.
2. Makes specific posters for each meeting and puts them up about one week before each meeting.
3. Fills in calendar in front hall.
4. Fills in bulletin board in each electrical engineering classroom.
5. Puts latest notices (AIEE and IRE St. Louis Sections) on bulletin board in front hall.
6. Mails out meeting notices one week previous to the meeting.
7. Devises new methods of advertising meetings.
8. Furnishes *Shamrock* (The University of Missouri's student engineering magazine.) with news of AIEE and IRE and furnish newspapers with news items.

Refreshment Chairman

1. Provides refreshments for each meeting.
2. Provides food for all open houses and spring picnic.

No mention has been made of actual programs, as that was not the intention of this article. However, the reference in the schedule of duties to the "Career Seminar" may need some explanation. Each year the St. Louis Section is kind enough to furnish the Student Branch with a panel of three or four speakers representing different phases of electrical engineering, to discuss career opportunities and obligations to be faced by the student upon graduation. Each year this proves to be a fine program.

A second item listed in the foregoing which calls for further comment is the serving of refreshments at meetings. These consist of soda pop, doughnuts, ice cream, or other modest refreshments served in the meeting room immediately after the meeting. When refreshments are omitted, the room is almost always empty within 10 minutes after adjournment. When refreshments are served, students, faculty members, and speakers linger in small discussion groups for periods of a half hour to an hour. It is felt that this opportunity for informal, friendly contact entirely justifies the effort and expense of providing the refreshments.

It is not proposed that all or any of these suggestions are unique. However, this general organizational pattern has speeded the Student Branch activity so much that it becomes possible to carry on a more extensive program than might otherwise be possible. It is hoped that some of these suggestions may have value for other Branches.

AIEE District Student Prize Paper Competitions

Each year the student branches in the various AIEE districts hold a District Prize Paper Competition. The contestants for the district contests are selected by local Student Branch Prize Paper Competitions. Any national Student Member of AIEE is eligible to participate by preparing a paper on some technical or engineering subject. The papers are judged both on the written and oral presentations. The Prize Rules were published in the September 1952 issue of *Electrical Engineering*.

Winners of Student Branch Competitions receive $10 cash, a certificate, and travel allowance to the District contest. The first-place winner of a District contest receives $25 cash, a certificate, and travel allowance to the next Summer General Meeting of the AIEE. All prize paper contestants may submit their paper for the national prize of $100 and a certificate.

In addition to the foregoing District prizes awarded by the Institute, several Districts are awarding expense paid inspection trips through laboratories, manufacturing facilities, and power stations. The Radio Company of America has sponsored excellent trips through their research laboratories and this year the Ohio Power Company, Pennsylvania Power and Light, and Consolidated Edison Company, and others are sponsoring trips in their AIEE Districts. Many Districts now have trophies for the winning school.

Several District Competitions have been scheduled: District 2—April 27–28 at Carnegie Institute; District 4—April 11–13 at Clemson College; District 7—April 2–3 at Southern Methodist University; District 11—May 11 at Case Institute of Technology.

Previous national winners have been: 1954, P. L. Frommer, University of Cincinnati, "An Electronic Blood Count Meter," vol. 74, 1955, pp. 388–391, *Electrical Engineering;* and 1955, Mark Biedeback, University of Southern California, "An Analysis of the Linear Pulsed Oscillator," vol. 75, 1956, pp. 171–175, *Electrical Engineering*.

The awards listed are but a part of the benefits derived from participation in a local or district contest. The opportunity of meeting fellow students from other universities, the association with leaders in the engineering profession, and the satisfaction of early professional achievement are not to be overlooked.

University of Missouri Publishes Centennial Bulletin

The College of Engineering of the University of Missouri formally launched its centennial celebration with publication of a special bulletin "One Hundred Years Ago" which gives a brief history of the teaching of engineering here for the past century. Most of the centennial activities took place during Engineering Week, which started March 11.

With an interesting but brief account of campus life before and after the Civil War, the bulletin presents excerpts from the University's annual catalogue for 1856 which showed that a professional course in civil engineering was well established at that time.

According to the bulletin, 1856 was established as a definite date for observance of the centennial, not only because the official University catalogue of that year listed two students as graduating with degrees in civil engineering, but also because the Board of Curators that year established the first professorship in engineering, naming W. A. Hudson as professor of natural philosophy, astronomy, and civil engineering, as well as president of the University.

Becket Memorial Award Established

Dr. H. B. Linford, professor of chemical engineering at Columbia University, and secretary of the Electrochemical Society, was given a check for $10,000 by A. L. Foscue, president of the Electro Metallurgical Company, to establish the F. M. Becket Memorial Award. Mrs. E. B. Folwell of Greenwich, Conn., daughter of Dr. F. M. Becket, witnessed the presentation. Dr. Becket, a pioneer in the production and use of ferro-alloys, for many years headed the research activities of Electro Metallurgical Company, a division of Union Carbide and Carbon Corporation, a major ferro-alloy producer. The award, in the form of a scholarship, will be available to students who have completed two or more years of study leading to a bachelors degree and are interested in the field of electrothermics.

LAFAYETTE BRANCH Secretary and Treasurer; R. B. Hanbicki, R. E. Reis, P. A. Gehman, F. R. Hand, C. T. Pearce, F. W. Smith, and D. R. Boone *(left to right)*.

Atomic Energy Talk by Pearce

C. T. Pearce addressed a large audience at the Lafayette College Joint Student Branch, in December 1955, in a talk entitled "Some Aspects of Atomic Energy." Mr. Pearce mentioned the different types of atomic reactors now in use or that will be in use in the immediate future. He told of the locations of present day reactors and their uses, of future installations, and of the companies which are building the reactors. He pictured the world power now being generated by atomic energy and that which will be generated in the future.

Courses for EE Students at Pennsylvania State University

The Pennsylvania State University recently added two new engineering options to help fill the growing demand of industry and the armed forces for engineers trained for missiles research. Students in electrical engineering may now select a missiles systems option and aeronautical engineering students may take an airborne systems option.

Courses in radar, computers, and automatic control systems will be given the aeronautical engineering students by the electrical engineering department while the aeronautical engineering will provide the electrical engineering students with courses in aerodynamics and aeroelasticity.

BECKET MEMORIAL AWARD check is presented to H. B. Linford (left) by A. L. Foscue as Mrs. E. B. Folwell looks on.

Graduate Opportunities Available at MIT During 1956–57

Broad opportunities for graduate study during 1956–57 at the Massachusetts Institute of Technology (MIT) have been announced by Dr. H. L. Hazen, dean of the MIT Graduate School.

Fellowships and assistantships for either teaching or research will be available during 1956–57 to help many students meet the costs of graduate study at MIT.

Further information may be obtained from Dean H. L. Hazen at Room 3-108, Massachusetts Institute of Technology, Cambridge 38, Mass.

A Solid-State Program Is Established

Syracuse University, keeping in stride with the nuclear age, has established a new academic program in solid-state science and technology.

The impetus for putting this new program into operation stemmed from a growing need by industry and research for more scientists and engineers with a thoroughly grounded knowledge of solid-state science and technology. Such a knowledge has proved an exceedingly useful tool in the invention of such solid-state engineering devices as transistors, ferrites, and phosphors. Inasmuch as heavy responsibility rests with today's engineer, it is his objective to solve problems that have evolved out of solid-state inventions, and out of the rapidly advancing fields of jet-powered planes and nuclear power plants.

The electrical engineer must cope with a whole new field of circuitry science that opened up with the invention of the transistor. The metallurgical engineer must develop new high strength noncorrosive materials for jet plane construction, and design these materials for use in nuclear power plants, as well.

It is this broad scope of the solid-state field that prompted Syracuse University to encompass in its program courses of study in two colleges—engineering and liberal arts, concentrating on the departments of chemistry, physics, electrical, mechanical, and chemical metallurgical engineering.

The numerous and varied properties of solids open several avenues of study in this field to people trained in physics, chemistry, metallurgy, theoretical and applied mechanics, and mechanical, electrical, and metallurgical engineering. It is to these people that the Syracuse program is open.

OF CURRENT INTEREST

DL-701 *LOCOMOTIVE hauling freight is designed both for road and switching service.*

Diesel-Electric Locomotive Has 12-Cylinder 1,800-HP Vee-Type Engine

RECENTLY, a new four-motor diesel-electric locomotive was introduced by Alco Products, Inc. The power plant for the versatile road switcher is a new design, 12-cylinder, 1,800-hp Vee-type model *251* Alco engine.

The *DL-701* locomotive displayed at Schenectady, N. Y., was the first off the production lines. However, orders for substantial numbers of the new units and several additional orders are pending.

Built for heavy duty freight, high speed passenger, and yard switching service, the *DL-701* is distinctive for its high hood line and angle-mounted number boards. The prototype unit was built with the long hood forward of the cab, but Alco will build the locomotive with the short hood forward—placing the engine behind the cab in forward motion—to conform to an individual railroad's specifications.

The company displayed the *DL-701* and the new *251* engine through February 10, and during the week-long showing officials of more than 25 railroads saw the nation's newest mobile power package.

The 251 Vee-Type Engine

The new *251* engine eliminates the free-end casing, camshaft idler gears and camshaft casing, water jackets, and generator adaptor used in Alco's model *244* engine. The *251* is turbosupercharged and has an air-intake aftercooler that effectively lowers temperatures in all combustion-affected parts.

Working parts in the new engine are totally enclosed to decrease wear, and a new fuel-injection system affords improved combustion with the added benefit of being dilution-proof.

Longer cylinder and valve life is forecast by the engineers, who have incorporated valve-seat inserts and hardened valve faces in the *251* engine. Piston and piston-ring longevity also has been increased, by a new type of insert piston, while piston rings are heat treated to make them compatible with the engine's chrome-plated cylinder liners.

The cylinder block of the new engine is stronger and heavier than that of previous engines. The Vee-type *251* has a wider and stronger center main bearing, with serrated fit between all main bearing caps and saddles. Grooveless main and connecting rod bearings increase oil-film thickness by more than 100 per cent, according to the company's engineers.

The engine includes a positive-action, mechanical overspeed trip that enhances the safety aspects of the heavy-duty power plant.

The DL-701 Locomotive

The *DL-701* locomotive incorporates several improvements over previous designs. Number boxes are angle-mounted and classification lights are variable-color and flush-mounted. The cab is longer, weathertight and has two heaters with fresh-air intakes. Gauges are of the dial type and are placed near control locations to permit convenient operation of the locomotive in either direction.

The locomotive has a 40-foot 4-inch wheel base and a maximum height of 14 feet 6 inches. Its maximum width is 10 feet $1^{5}/_{8}$ inches and it is 56 feet $11^{3}/_{4}$ inches long inside the knuckles. The wheel base of each truck is 9 feet 4 inches and truck wheels are 40 inches in diameter. Roller-bearing trucks and a rubber draft gear are standard equipment on the *DL-701*.

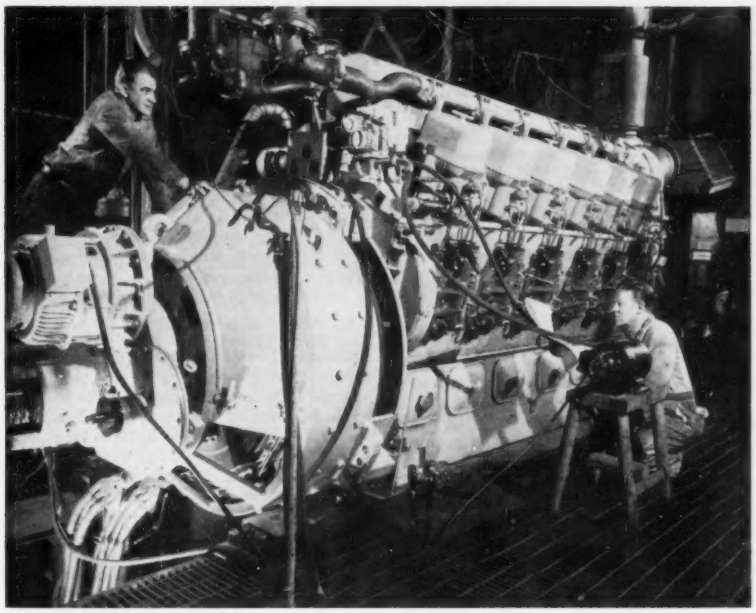
The locomotive's base weight is 240,000 pounds and it can be ballasted to 260,000 pounds.

Electrical Equipment

Improvements in the basic electrical controls offered in the *DL-701* include a greatly simplified engine control with individual push-button start and stop, and a simple, two-position engine-control switch with idle or isolation and run positions.

In fuel-rate control, the *DL-701* governor provides timed rate of fuel advance that offers throttle-cushioned duty on the engine, cleaner exhaust during acceleration and permits throwing the engine on the line in transit.

The number of relays has been drastically



ALCO'S NEW DESIGN MODEL *251*, 1,800-hp Vee-type engine on test stand, where each engine is run a minimum of nine hours under close inspection. The engines are tested a second time on waterbox, after installation in a locomotive.

reduced, leaving heavy-duty, tamperproof relays where required. The rugged new ground relay has a trip signal and reset button accessible in the cab without opening compartment doors.

Nearly all amphenol connectors are replaced in the *DL-701* by terminal boards, giving improved reliability and saving maintenance time and expense by cutting the number of soldered connections. All wire and cable is insulated with improved, neoprene-jacketed rubber and is wire-way installed.

The static excitation system gives high reliability and low maintenance. It contains only one rotating machine; a 3-phase alternator, with two slip rings and no commutator; and has positive inherent control of horsepower, voltage, and tractive effort. The static control of the system is contained

FREIGHT CONDUCTOR waves at fireman of *DL-701* road switcher locomotive as the 1,800-hp unit overtakes his caboose on a main-line track.

Future Meetings of Other Societies

Air Force Cambridge Research Center Headquarters, Symposium: Microwave Properties and Applications of Ferrites, sponsored by Air Research Command, Harvard University, and IRE, April 2–4, Harvard University, Cambridge, Mass.

National Science Foundation and Atomic Energy Commission, 6th Annual High Energy Nuclear Physics Conference, April 3–7, Rochester, N. Y.

Electrical Industry Show, April 5–7, Shrine Exposition Hall, Los Angeles, Calif.

ISA, 2nd Annual Southwestern Region Instrument Conference and Exhibit, April 5–7, Dinkler Tutwiller Hotel, Birmingham, Ala.

American Chemical Society, 129th National Meeting, April 8–13, Dallas, Tex.

Canadian Institute of Mining and Metallurgy, Annual General Meeting, April 9–11, Quebec, Ont., Canada.

SAE Aeronautic Display, Aircraft Production Forum and Engineering Display, April 9–12, Hotel Statler, New York, N. Y.

Symposium for Management on Applications of Analogue Computers, sponsored by Midwest Research Institute, April 10–11, University of Kansas City, Mo.

IRE, 7th Regional Technical Conference, April 11–13, Hotel Utah, Salt Lake City, Utah.

Institute of Radio Engineers, Spring Technical Conference, April 13–14, Engineering Societies Building, Cincinnati, Ohio.

Atomic Industrial Forum, Regional Conference, April 17–18, Atlanta, Ga.

Machine Tool Forum, 20th Annual Westinghouse Meeting, April 17–18, Hotel Statler, Buffalo, N. Y.

"Research for Profit" Conference, sponsored by Armour Research Foundation, April 18–20, Illinois Institute of Technology campus, Chicago, Ill.

Environmental Equipment Institute Science Section, 2nd Annual Meeting, April 19–20, Sheraton Hotel, Chicago, Ill.

Pennsylvania Electric Association Meter Committee, Spring Meeting, April 19–20, Roosevelt Hotel, Pittsburgh, Pa.

Protective Relay Engineers, 9th Annual Conference, April 23–25, A & M College of Texas, Electrical Engineering Department, College Station, Texas.

International Union of Pure and Applied Physics, International Conference on Electron Physics, April 23–25, National Bureau of Standards, College Park, Md.

British Industries Fair, April 23–May 4, Olympia Hall, London, England.

ISA, Electronic Controls in Industry—Control Systems Engineering Symposium, April 25, Hotel Du Pont, Wilmington, Del.

Nonlinear Circuit Analysis II Symposium, Polytechnic Institute of Brooklyn, April 25–27, New York, N. Y.

7th Annual Engineering Conference, Symposium: Engineering—The Summation of the Sciences, April 26–28, Virginia Polytechnic Institute, Blacksburg, Va.

Electrochemical Society, 4th Annual Semiconductor Symposium, April 29–May 3, Mark Hopkins Hotel, San Francisco, Calif.

Society of Motion Picture and Television Engineers, 79th Convention, April 29–May 4, Hotel Statler, New York, N. Y.

Chamber of Commerce of the United States, Annual Meeting, April 30–May 2, Washington, D. C.

Verein Deutscher Ingenieure, Centenary Celebration in Berlin, May 12–15, V.D.I., Prinz-Georg-Strasse 77/79, Dusseldorf, Germany.

in four dead-front interchangeable panels which may quickly be checked and replaced if defective.

Available Modifications

Among modifications available to meet customer specifications are gear ratios providing four choices of speed and tractive effort. Gearing at 65 mph produces a continuous maximum tractive effort of 53,000 pounds, gearing at 75 mph produces a maximum effort of 46,500 pounds, a 43,400 pounds maximum effort results from gearing at 80 mph, and when geared at 92 mph a maximum of 38,000 pounds of tractive effort is developed.

A dynamic brake system has the highest capacity usable, and is automatically controlled by nonmoving devices. It has a new blower motor circuit that insures against grid damage due to loss of air during a wheel-slip.

Three steam generators are available for the *DL-701*, with individual capacities of 1,600; 2,750; or 3,500 pounds per hour. Generator water capacity is 1,400 gallons.

The *DL-701* can be made with fuel capacity up to 2,600 gallons when a boiler is not used.

Auto Engine Faults Are Pinpointed by Electronic "Auto Mechanic"

A REVOLUTIONARY new electronic "auto mechanic" which can pinpoint engine troubles in a matter of seconds was demonstrated by Allen B. Du Mont Laboratories, Inc., in New York, N. Y., recently.

The instrument, resembling a portable television receiver, was shown to members of the press at a preview held at Majestic Buick, 1731 Broadway, New York City. Called the Du Mont TV-Type Engine Analyzer, it visually pointed out on its picture tube the engine faults of automobiles being tested.

Ignition troubles such as a shorted spark plug, a loose lead to the distributor, and a leaky wire were found immediately by observing the change in picture patterns on the television-like screen.

The guesswork of motor repair work is eliminated by enabling mechanics to pinpoint the source of trouble accurately in a matter of seconds. It takes the time-consuming detective work out of servicing.

This device, which will be sold nationally to auto service stations, automobile dealers, fleet owners, and repair shops, is the result of 14 years experience in the field of electronic engine analyzer development for industry and the armed forces.

The new instrument has been released to the general automotive industry after four years of laboratory development and intensive testing of actual operation in test areas.

The analyzer can detect a wide variety of automobile ailments including fouled, misfiring, open or shorted sparkplugs; defective coils, condensers, wiring, and switches; worn distributor cam and shaft bearings; as well as burned distributor points, one of the chief causes of poor engine performance. In addition, it will diagnose pre-ignition faults as well as troubles caused by noise and vibration or combustion knock. The instrument may also be used to check ignition timing operation of intake and exhaust valves.

In operation, the device which resembles a portable television receiver, is connected to the ignition system of the engine by two simple clip-on leads. These leads are never moved throughout the tests. Engine troubles show up on the instrument's picture tube in the form of patterns of light. By observing these patterns, the auto mechanic can tell in a few seconds what ails the engine, thus taking the time-consuming detecting work out of servicing.

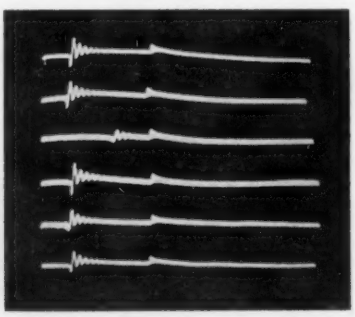
The engine analyzer, which weighs less than 60 pounds and is approximately the size of a suitcase, gives simultaneous pictures of the behavior of each cylinder in an operating engine.

The device may be used either with a standard 117-volt a-c source or receive its power from the battery of the car being tested. The latter feature permits the car to be road tested, inasmuch as the leads are long enough for the instrument to be placed on the floor of the car, ahead of the front seat. Road testing is an important advantage, because many faults found in modern engines show up only when the vehicle is in operation.

The electronic "mechanic" quickly identifies a wide variety of engine troubles, and can be operated with only a brief period of instruction for the human mechanic.

As an aid in learning to interpret the television-type patterns which appear on the tube face of the instrument, Du Mont engineers have prepared a booklet composed of charts which list numerous engine faults and show the pattern caused by each fault. By checking the booklet the beginner can readily spot each fault and take the necessary steps to remove it.

The new instrument, which has been designated as the Du Mont Type *901* TV-Type Engine Analyzer, was developed in co-operation with the Socony Mobile Oil Company and is being manufactured by Du Mont under a licensing agreement with the Socony organization.



CHECKING OUT engine performance of sports car (*left*) in the time it takes to refuel at a sports car meet, the revolutionary new electronic "auto mechanic," developed by Allen B. Du Mont Laboratories, Inc., pinpoints auto engine troubles in a matter of seconds. An uncomfortable ride in your car will result if this light pattern picture (above) shows up on the screen of the Du Mont TV-Type Engine Analyzer. There's a shorted sparkplug on cylinder #3 (note change in pattern on third line from the top) and that means misfiring, vibration, loss of power, and fuel waste.

Long-Range Program for Better Living in America Is Outlined

THE UNITED STATES is strong and wealthy. Her people eat well, dress well, and play well. But many—too many—do not live well, because they live on streets and in neighborhoods that have started to decline, to grow shabby, and to decay. The death of a neighborhood is tragic. The tragedy is that, too often, the rest of the community turns its back on such neighborhoods. As a result, some part of the whole community dies with it.

The Nation's Main Asset

One of the country's biggest assets is its housing inventory valued at upward of $250 billion. This is more than 2.5 times the total assets of 500 of America's largest corporations. Furthermore, since World War II, an astonishing total of a million new homes per year have been built in the United States. However, more than half of these need annual routine maintenance to remain physically acceptable.

And the reason behind this situation is public apathy. Public apathy, inadequate information, and individual loss of pride in homes is threatening a primary national asset. It is to remove this apathy and to stimulate an increasing pride in the home that ACTION (American Council To Improve Our Neighborhoods, 2 West 46th Street, New York, N. Y.) was organized.

Ford Foundation Grant

A $250,000 grant for housing research to ACTION was announced by Andrew Heiskell, ACTION's board chairman. The Ford Foundation grant is believed to be the largest ever given by a foundation for research in this field. It will be used to investigate "impediments to the provision of adequate housing and the means to remove these impediments."

Martin Meyerson, executive and research director of ACTION, who is on leave from the city planning faculty of the University of Pennsylvania, will supervise the project. One of the first steps to carry out the study will be to identify the main factors impeding the provision of adequate housing for all income groups. Among the factors to be considered for detailed study are: incentives for investment, relocating residents from blighted districts, development of housing code enforcement in metropolitan areas, rehabilitation costs, conservation and redevelopment, and standards of public services to improve or maintain a satisfactory environment for good housing.

A series of special technical committees of outstanding experts from trade and other national associations, from industry, Government, and universities will aid on each of the main problems selected for study. One of the most important aspects of the project will be the full use of ACTION information and field service resources to implement the research findings.

Public enemy number one—current model—has two horns, a sardonic leer and a soft job. He is the Devil's project supervisor, Division of Urban Destruction, and is currently starring in what may be his last movie.

"Man of ACTION," a new film which features this urban saboteur, is now available nationally. The 13½ minute color cartoon was produced for ACTION by Transfilm and contributed as a public service by Continental Can Company. It is a key tool in the national citizen organization's drive to stop the deterioration of America's homes and neighborhoods.

The Devil's accomplice, a symbol of citizen apathy which has made housing decay our prime social and economic problem, barely has to lift a finger to create slums. In an entertaining way, he demonstrates how people themselves do the Devil's work.

Taking issue with him is an average homeowner who lives in a nice average neighborhood. This citizen hero turns back blight at his own front door through home repair, then goes on to organize his community to abolish its shameful slums and prevent future ones from growing. When last seen, the thwarted villain is hopping a fast freight out of town on his way to other communities (perhaps yours!).

"Man of ACTION" in 16 mm is available on free loan to adult community groups, industry, and television stations through Association Films' regional libraries.

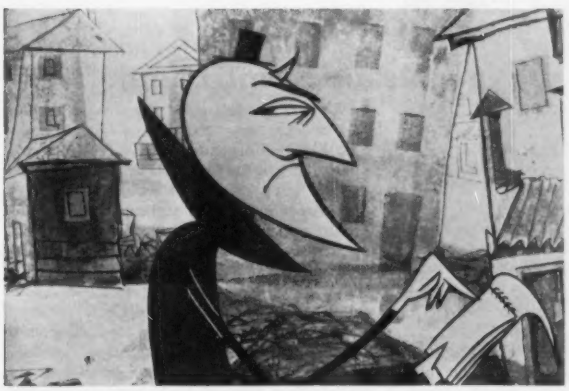
Electrical Industry Assistance

The renewal costs were estimated in a survey made by the Twentieth Century Fund based on 1950 figures and projected to a 1960 goal. It showed that local electric and gas utility needs and costs would increase by at least 12%.

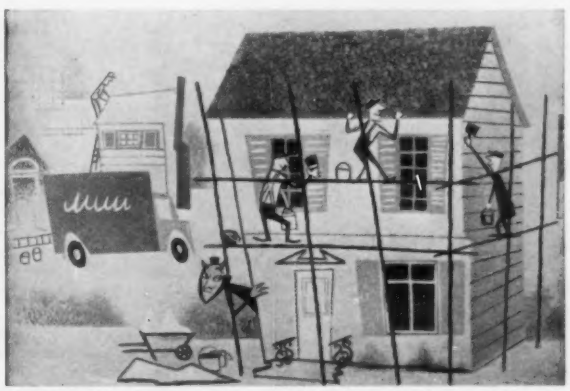
The electrical industry can help by looking for such things as obsolete and inadequate electric service. Such questions as: "Is electric service adequate? Is insulation frayed on exposed wires?" could easily be checked to assist in mapping out a campaign of improvement. It would be advantageous for the utilities and manufacturers in the electrical industry to work with the chamber of commerce and groups like ACTION and OHI to ensure that electrical living becomes synonymous with home improvements—modernizing kitchens, laundry rooms heating and waterheating, and improving lighting throughout. Being prepared to respond to the increase in service demands resulting from the publicity will be necessary and desirable, inasmuch as an improved community is more attractive to any new industry.

The rewards of the community and slum rehabilitation efforts for participants in these programs are: increased valuation for the home owner; added materials and services sales for builders, contractors, and manufacturers; more need for electrical wiring and appliances supplied by utilities: and far more demand for electrical appliances to be manufactured and sold by local dealers.

The nation will benefit by this "beauty treatment" because whereas now visiting foreigners call our cities "ugly" when they see the slums—we are world-famous for them and wholly ashamed—when the improvements are accomplished, such remarks would have no more basis in fact.



PUBLIC ENEMY NO. 1—current model—in America is the Devil's urban destruction supervisor who is checking off his slum timetable.



MAINTENANCE AND REPAIR of homes keep the Devil on the run in "Man of ACTION," a new color film spotlighting what citizens can do to prevent slums.

Hurricanes—Research To Be Made by Scientists Before, During, and After

A DETAILED STUDY of how sea surface temperatures influence hurricane birth, growth, and decline will be made by New York University (NYU) meteorologists for the next 12 months under a $17,500 grant from the United States Weather Bureau.

The grant was announced by Dr. H. K. Work, director of the Research Division of the NYU College of Engineering.

The NYU project is part of the Weather Bureau's extensive research program launched after last year's devastating East Coast hurricanes. Congress has made an initial appropriation of $500,000 for the national program.

Besides studying Diane, Hazel, and their sister storms of 1955, NYU researchers will look back at the 1938 New England hurricane and other major hurricane disasters of the past.

Scientists have known that ocean waters warm up before hurricanes are born over them. The object of the NYU study is to determine how sea surface temperatures before and during a storm may be used to obtain more accurate forecasts of its path, intensity, and time schedule in order to warn areas to be affected in advance of storms in the making.

The study will cover a sea belt at least 500 miles wide off the entire East Coast. Particular attention will be paid to the temperatures of waters immediately offshore to determine how they influence the path of hurricane as it reaches land.

According to past statistical studies, hurricanes generally do not form in ocean areas where the normal sea surface temperature is below 82 F.

One of the toughest problems in the study will be the scarcity of data for the hurricane season. Available records of sea temperatures taken by freighters and passenger ships go back well into the 19th century. But ships naturally try to avoid hurricane breeding areas in season. And those unlucky enough to come close to a hurricane give low priority to the taking of temperatures for scientific purposes.

The NYU study will also touch on the relationship of the general circulation of the atmosphere to hurricane development. From sea level to its uppermost layers, the atmosphere flows in large, clearly definable streams. Hurricanes, it is known, follow these large paths, just as a strong whirlpool of water is carried along in the direction of a flowing river. The investigators will try to establish specific relationships—in terms of speed and direction—between hurricanes and the general atmospheric circulation in which they are imbedded. As in the sea surface temperature analysis, the goals are improved tools with which hurricane forecasting can be accomplished.

In an important step in the program to learn more about hurricanes and improve hurricane forecasting methods, the U. S. Weather Bureau, has asked General Precision Laboratory (GPL), Inc., Pleasantville, N. Y., to equip three multi-engine planes with the latest electronic meteorological instruments and navigation gear.

These planes, a jet B-47 and two piston engined B-50 Bombers, will be the most completely equipped meteorologically and will fly around and through hurricanes at different altitudes, so that the instruments can determine and record data needed by the weather services in their hurricane studies.

A three-foot photo panel permits continuous photographing of 21 data channels including time, latitude, longitude, ground speed, drift angle, compass heading, air speed, wind direction, wind speed, humidity and temperature.

A digital recorder, which includes a modified IBM calculator, will record every quarter mile for computer use nine information channels including time, latitude, longitude, wind direction and speed, and temperature.

Providing the information for both camera and digital recorder is Radar Set *AN/APN-81*, developed and manufactured by GPL, which is the only self-contained automatic navigation equipment in production today. Free of dependence on ground aids or celestial fixes, this equipment furnishes continuously the necessary ground speed and drift angle information needed for the meteorologist and cloud physicist to determine hurricane location. In addition, it also measures wind velocity and direction needed for basic hurricane research and forecasting.

The bombers are being provided and flown by the Air Force's Air Weather Service and, in addition, will carry technical staff assigned by the Weather Bureau.

The continued need for weather information about hurricanes has many groups investigating various devices which may eventually evolve into the forerunners for weather controls.

The National Bureau of Standards (NBS) and the Navy are developing an automatic weather station that can be parachuted into the eye of a hurricane to radio back information about wind speed and direction, barometric pressure and air and water temperature.

The automatic weather station was put together from a similar World War II device in time for a brief tryout in the 1955 hurricane season. It reported on hurricane Janet during her journey across the Caribbean Sea in late October.

Under development at the request of the Navy Bureau of Aeronautics by P. D. Lowell, William Hakkarinen, and L. M. Allison of NBS and W. A. VonWalk of the Naval Research Laboratory, a newly designed weather station is being constructed for larger scale tests during the 1956 hurricane season.

With a 500-mile range, the automatic weather station can be used to monitor hurricane breeding grounds on a free drift basis as well as for full blown hurricanes. It can also be used to report weather from unfrequented or inaccessible water areas. The device was demonstrated when Secretary of Commerce Sinclair Weeks and NBS Director A. V. Astin were host to leaders from science, industry, education, and Government. The weather station is a prime example of the theme of Guest Week—The Science of Measurement. It is but one important development growing out of the Bureau's program for the establishment and search for improved physical standards, new measurement techniques, and their application to the accurate measurement of scientific phenomena.

The present automatic weather station, similar to a buoy, weighs about 300 pounds. Its main section is about 5 feet long and $1\frac{1}{2}$ feet in diameter. With antenna and keel it is about 25 feet over-all.

It is self powered from batteries and operates unattended day and night for a period of about 6 weeks after launching. Weather reports are broadcast in code every two hours and can be picked up by any shore or ship receivers within its 500 mile range.

RF Tantalum Light Is Much Brighter Than Any Incandescent Lamp

USING A 3.5-MC OUTPUT from a 1.5-kw oscillator as a power source, a new multipurpose lamp was introduced recently by Sylvania Electric Products, Inc. The lamp transforms this radio-frequency energy into light energy so brilliant that it is brighter than any incandescent lamp devised.

Since it was established that a bright, uniform, continuous source was desired, it was decided to design a lamp that was as close to the ideal as possible even though the power supply might be bulky or the cost rather high. The obvious way to accomplish this would be to somehow heat a solid disc made of highly refractory material to a very high temperature. Such a light source would be bright if it were heated to a high enough temperature; it would be uniform if a proper method of heating could be employed; and it would be stable if the refractory material were to remain solid.

The highest melting materials available today are the carbides of zirconium, tantalum, and hafnium. Fortunately, these materials are also electrically conductive and, therefore, make electrical heating possible. In fact, some early work had been done by Cooper and Pieroni on incandescent lamps made with tantalum-carbide filaments. Since filaments could not provide a uniform

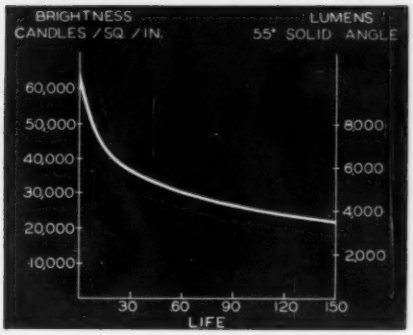
source and a solid source could not be heated by direct conduction, it was decided to try induction heating of a disc by r-f power.

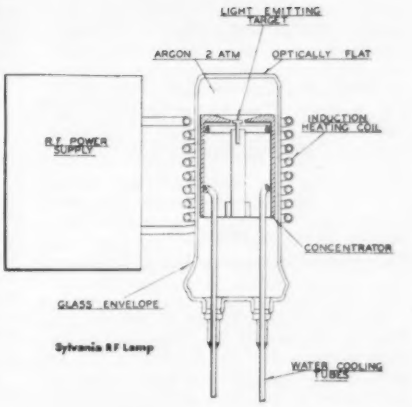
The first attempts at building such a lamp were successful in arriving at a lamp that could give brightnesses above that of tungsten incandescence, but the life was short and the power supply was large beyond all reason. After much effort was spent toward pre-processing the material and improving the r-f efficiency, a practical lamp resulted. The lamp, Sylvania Type *AN20*, involved a 5/16 inch tantalum-carbide disc supported by a zirconium-oxide rod. Concentration of the r-f field was accomplished by means of a split copper cylinder inside the glass envelope. A copper coil provided a means of coupling the r-f oscillator to the copper cylinder. A schematic drawing of the lamp and power supply and a picture of the lamp can be seen illustrating this article.

Most incandescent lamps are rated in terms of the total lumens given out in a 360-degree solid angle. In a system that involves optics, however, the amount of light that is picked up by the condenser lens is of more interest, about 55 degrees. The graph shows the manner in which life varies with the lumen output and the brightness. A 750-watt biplane projection lamp has an average brightness of about 21,000 candles per square inch. It can easily be seen, therefore, that both longer life and higher brightness can be obtained from the RF Lamp than from a projection lamp.

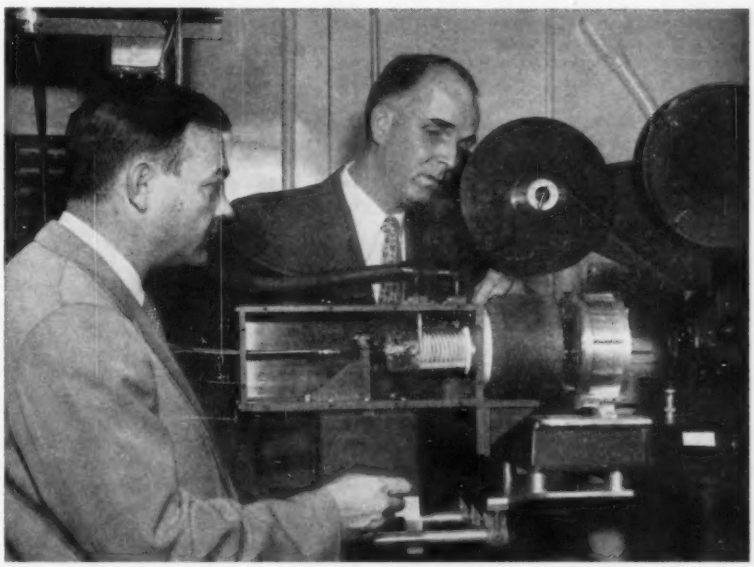
Motion Picture 35-mm Printing

Printing of 35-mm movie film requires certain characteristics in the light source that are unique for this application. It is necessary to have a bright lamp to increase the printing speed; it is necessary to have a uniform source so that the light distribution across the film gate is uniform, and that the lamp be very stable with respect to time; and it is also necessary that the light's color be well balanced for all three primaries: red, green, and blue. The RF Lamp is superior in these three characteristics to any incandescent lamp. Although it is not as bright as a carbon arc, it is so much more uniform and stable that the end result is better than that of a carbon arc. The RF Lamp has satisfactory life when it is operated at a brightness level which allows a factor of 8 improvement in printing speed over a 1,000-watt biplane incandescent. Furthermore, it can be replaced more easily than a projection lamp inasmuch as its uniformity does not impose a critical requirement on an alignment of a reflector or lamp. It has been stated that it sometimes takes four hours to replace an incandescent lamp. It appears that the RF Lamp can be replaced in approximately one hour at most. The color balance of the RF Lamp has provided a means of obtaining color quality that was not possible with any other light source. It should be understood that that brightness of the RF Lamp is not sufficiently greater than an incandescent lamp to give anything like a factor of 8 improvement in printing speed; however, its uniformity is so much better that the light can be used in a more efficient manner by the optical system and, therefore, explains the great improvement. Since the lamp is a higher color temperature than an incandescent lamp, it provides more light output in the blue region which is now the





RADIO FREQUENCY furnishes the power to make the new RF Lamp *(above)* burn more brilliantly than any other incandescent lamp ever used. Some applications for the lamp include color television tube manufacture, medical research, radar and air traffic control, computers, and projectors. The new concentrated light source activated by radio frequency has no direct electrical connections as seen in the diagram *(top right)*, yet is more brilliant than an incandescent lamp. Graph *(bottom right)* gives variation of life with lumen output and brightness.



SCIENTIFIC ASPECTS of movie printing are explored by Sylvania engineer R. H. Lindeberg *(left)* and Dr. A. J. Hill, physicist for the Motion Picture Research Council. The printing machine is equipped with Sylvania's new RF Lamp which improves print quality and substantially reduces printing time.

"bottle neck" in printing. Optical printers cannot make so much advantage of the uniformity and printing speeds are only slightly better than that obtained by a thousand watt biplane lamp run at full voltage. However, the quality of the finished picture is much better here and since the life of the RF Lamp is greater than that of an incandescent, there is considerable savings in the time that would normally be required to replace the lamp.

The contact printer is normally used for release prints; that is, to take a finished print and duplicate it for distribution to the theaters. Luckily, this is where the printing speed is greatly improved by the use of the RF Lamp.

The picture shows an RF Lamp adapted to an Acme contact printer at Consolidated Film Industries, which developed the method of mounting the lamp and performed exhaustive tests to determine its feasibility in this type of application. The condensing lens was developed by the Motion Picture Research Council and was a very important contribution toward making the lamp feasible. Early tests indicated that a high degree of uniformity across the light source target was necessary. This lead to lamp developments which have resulted in a brightness uniformity of better than 5 per cent.

Concordance of Bible Compiled Electronically by Univac

A complete concordance of the Revised Standard Version of the Holy Bible compiled electronically by Remington Rand's giant Univac Computer will be ready for publication in early 1957, it was announced by Thomas Nelson & Sons, publishers of the concordance.

Members of the Division of Christian Education of the National Council of the Churches of Christ in the U.S.A. were told that every one of the more than 800,000 words in the latest translation of the Bible has been recorded on four metal magnetic tapes used by the giant Univac. As the words are fed into the electronic data processing system for the tape, the computer stores all but 132 frequently used short words in its mercury "memory" and arranges the stored words alphabetically with their context and location in the Bible—book, chapter, and verse.

The mammoth undertaking was initiated little more than two years ago, a striking comparison with the 30 years it took James Strong to compile the exhaustive concordance first published in 1894. It is estimated that the printed concordance will contain more than 350,000 contexts.

The idea of producing a concordance of the Revised Standard Version through electronic means was first conceived by the Rev. J. W. Ellison, rector of the Church of the Epiphany (Protestant Episcopal) of Winchester, Mass., while preparing his thesis for a doctorate at Harvard Divinity School.

Programmers at the New York City Univac Computing Center, working under Mr. Ellison's guidance, made a test concordance of just two books of the New Testament, the Gospel according to St. Mark and the Epistle to the Romans. When the results proved highly satisfactory, the real work of processing the entire Bible from the book of Genesis through Revelations was begun.

The first step in the gigantic undertaking was to copy the entire Revised Standard Version onto magnetic tape by means of the Unityper, a machine with a keyboard much like a standard typewriter. The typists copied letters, numerals, and punctuation exactly as they appeared in the Bible, and the Unityper automatically translated each character into a series of magnetic dots on the tape. The process was started in February 1955, and completed in November, a 9-months task, with all 800,000 words recorded on just 4 reels of tape.

The computer rejects automatically all articles, short conjunctions, short adverbs, frequently used short verbs and most prepositions. Scanning each word on the magnetic tape, the Univac makes, at the speed of light, eight successive comparisons to determine whether or not the word is to be stored, then automatically sorts the stored words and their contexts alphabetically. Out of the system comes a printed listing of every context containing each word, arranged according to order of appearance in the Bible, and a complete description of its location, such as:

ANOTHER

and said to one A., "Who then is	Mk4.41
And they discussed it with one A.,	8.16

In the meantime, the means for carefully checking the accuracy of the tapes were being readied. A complete set of punched cards was prepared independently, containing the same information as the tapes. The cards were processed through a Univac Card-to-Tape Converter, which produced a second series of four tapes for checking against the first series.

Utilizing the ability of Univac to compare likes and unlikes electronically both series of tapes were fed into the systems. Every discrepancy due to transcription was noted and a corrected series of tapes prepared.

Gearing Univac for the enormous task of word grouping and alphabetizing was assigned to one of Remington Rand's highly specialized programming teams. A four-step routine of instructions was set up. In Step 1, Univac was given instructions for identifying the key word and building up its context and location. In Step 2, Univac was told how to eliminate the 132 words that were not to be processed. Step 3 assigned numerical weights to initial letters in order to arrange them in alphabetical order. In the final step, the system was told how to edit the data ready for typesetting.

Once programmed, the Univac Central Computer can scan all four tapes in a little more than 15 minutes, producing with the speed of light any item of information for the printed output. Univac will record the entire concordance on tape in about 120 hours. Pulsing at the rate of 2.25 million times per second, the machine releases, in the order of the programmed routine, the 91 electronic pulses that make a Univac word and records them on the output magnetic tape. This tape, in turn operates the Uniprinter which prints on manuscript sheets ready for typesetting the contexts which the computer has now arranged in alphabetic sequence. It is estimated that the completed copy for all of the 350,000 contexts will be Unityped in 1,000 hours.

This material from Univac is then delivered to the typesetters who will follow the usual procedure for the manufacture of a book. After typesetting, printing, and binding, this huge book (approximately 2,000 large pages) will be available to scholars and students of the Holy Bible. This process, of course, takes several months but it is certain that the complete Concordance will be available by Spring 1957.

Improved Technique for Making Transistors

A new and improved technique for making transistors and other "solid-state" devices from germanium has been developed by scientists at the Westinghouse Research Laboratories, it was announced by Dr. Clarence Zener, acting director of Westinghouse research.

The new technique already has been employed at Westinghouse to make two improved types: (1) a transistor capable of efficient operation at extremely high frequencies such as those encountered in television and other high-frequency electronic devices, and (2) a special transistor, called a photodiode, which is 10,000 times more sensitive to light than a conventional photoelectric cell, or "electric eye," yet can control a hundred times more current.

The conventional methods of making transistors rely on delicate temperature control to achieve quality and consistency in the finished product. Ordinarily, a thin slice of n-type germanium is placed between two layers of the metal and heated. The metal atoms "dissolve" inward through the germanium, forming two outside layers of p-type germanium, and leave a very thin n-type layer between them. The thinner and more uniform the n-layer, the better the performance of the finished transistor.

High temperatures cause the very thin layer of n-type germanium to melt away completely, leaving the transistor worthless. Low temperatures leave the n-layer too thick, thus a transistor with poor performance.

In contrast, the new Westinghouse process can allow the temperature to be virtually uncontrolled—which means that, compared to conventional methods, the process inherently produces transistors more consistent in quality from unit to unit.

Key to the process, is a "cooling off" period during the heating of the transistor. The process allows the critical n-layer to build up to the desired thickness and uniformity instead of being inexactly dissolved away, as in conventional methods.

Although not yet applied to full-scale manufacture, the new process, on a laboratory scale, has produced transistors with unusual performance. Such transistors can amplify electrical pulsations many times higher in frequency than those handled by the usual junction-type transistor. This means that soon we may see high-frequency electronic equipment—including home television sets—fully transistorized, with the usual array of electronic tubes completely replaced by transistors.

The conventional photo cell requires vacuum tubes, transformers, and other bulky circuit components to furnish power to the tube and amplify its small electrical output. The new photodiode needs none of these. It operates on a voltage as low as that from a

1½-volt dry cell or 6-volt storage battery yet actuates a standard relay.

Gamma Radiation Detector Checks "Fever"

A simple, rugged little detector that tells at a glance how much deadly gamma radiation the body has absorbed, thus providing a constant check on gamma fever, has been perfected for the Army and civil defense after exhaustive testing by the Signal Corps Engineering Laboratories at Fort Monmouth, N. J.

The "Fountain Pen" Dosimeter, weighs two ounces, is four inches long, and one-half inch wide, known technically as Radiacmeter *IM-93*, was developed by Bendix Aviation Corp., Cincinnati Division, for Army troops, and records gamma radiation up to 600 roentgens.

A medically recognizable dosage is about 25 roentgens. Over 100 will produce first signs of radiation sickness, and usually 400 will kill 50 per cent of those exposed.

An easy-to-read scale reveals the total radiation the body has been exposed to over the time the dosimeter is carried. The new Signal Corps dosimeter is clipped in the pocket like its namesake pen or a clinical thermometer. Unlike the others it needs no delicate handling or special care. In tests it worked perfectly after being thrown 20 feet against a solid wall and dropped on a concrete floor. It also operates after immersion in water and at high altitudes. It is unaffected for all practical purposes by arctic cold or desert heat. It can be stored indefinitely before use, giving it a marked advantage over the commonly used photographic badge dosimeters.

In addition, after its original electric charge, the instrument can be used over and over again for years with infrequent recharge. Once the dosimeter is charged, it can be read at any time. The user merely peers through a lens in one end, with a light source at the other, as he might look through a pint-sized telescope.

The instrument uses a quartz filament fiber activated by an electrical charge stored in a special aluminum and plastic foil capacitor. As gamma rays ionize the air inside the filament chamber, the quartz fiber moves across the scale.

A light in the flashlight battery powered charger allows the dosimeter to be adjusted, so that the scale can be returned to zero or show the reading previous to charging. For emergency civil defense use, it also could be recharged by almost any trained television or radio repairman.

NSF Grant Given University of Wisconsin

The University of Wisconsin has received a grant of $249,700 from the National Science Foundation (NSF) to inaugurate an experimental program to train high school teachers to teach science and mathematics more effectively.

The program will begin next fall with 50 high school science and mathematics teachers, chiefly from 7 North Central states.

THE TELEPHONE SET displayed contains a musical tone device which may someday replace the telephone bell. The tone radiates through the louvered area at the base of the set.

The program is being tried first at the University of Wisconsin and Oklahoma Agricultural and Mechanical College. If successful, it will be expanded to a total of eight schools in the academic year 1957–58.

Each teacher will receive $3,000 with an additional allowance of $300 for each dependent, plus tuition fees and travel allowances.

Each teacher selected to participate in the program will pursue studies designed to increase individual effectiveness as a teacher, and each will be able to take refresher courses in the fundamentals of biology, chemistry, mathematics, or physics, seminars in teaching methods, regular university science courses, and university courses devoted to the influence of science upon modern life.

To be eligible for selection to participate in the program a teacher must have a bachelor's degree, have taught for three or more years, be teaching science or mathematics, show scholastic and teaching ability, and be under 46 years of age.

The supply of qualified high school science and mathematics teachers may be increased not only by recruiting and educating new teachers but also by enhancing the competence of present teachers. It is the latter approach that the new program will follow, by increasing the teacher's knowledge of science and mathematics particularly relevant to the subjects which he teaches.

A typical pattern in all but our largest high schools is for the science teacher to teach in more than one field. Often he teaches science or mathematics in addition to some nonscience field which is his primary interest.

The University of Wisconsin will draw most of its students from Wisconsin and adjoining states. Oklahoma A&M will draw its teachers largely from the south central area states.

Musical Jingle Replaces Telephone Jangle

An experiment with a new musical tone device which may some day replace the telephone bell has been reported by Bell Telephone Laboratories.

The first major field trial of the new device will take place in the Crystal Lake, Ill., area next Spring.

The experimental site was selected for the variety of telephone equipment it affords. Some 300 customers on 100 telephone lines, ranging from individual to 8-party rural service, will be asked to participate.

The musical tone equipment uses transistors, which are rapidly taking over many functions in telephone communications.

In this experiment the tones will be transmitted with the same amount of power required for a telephone conversation—considerably less than is needed to make a telephone ring. The ordinary telephone bell requires 85 volts; the transistorized device operates on less than a volt.

The experimental telephone sets in Crystal Lake will be almost identical in appearance with the latest models placed in service by the Bell System.

Alterations in the telephone central office at Crystal Lake and on telephone lines there will not affect the customer.

Limited field trials and laboratory tests already indicate some of the advantages of the musical tone. Reactions of a "jury" of men and women participating in laboratory tests showed that the musical tone can be heard at great distances. It stands out above general room noise and can be distinguished from such sounds as the ringing of doorbells, alarm clocks, and fire alarms.

An advantage rated high by Bell scientists is that the new device is an aid to the partially deaf. This is because the musical tone contains more energy in the middle frequency range where there is ordinarily less loss of hearing acuity.

Electrofax Process Makes Printing Plates Faster

A swift new method of preparing offset and photoengraving printing plates, involving a single photographic operation that is thousands of times faster than conventional methods was described by H. G. Greig, a staff scientist of the Radio Corporation of America, at the meeting of the Rochester

Section, Photographic Society of America.

The new process, employing the RCA Electrofax system of electrostatic photography, presents an entirely new set of tools for use in the graphic arts. It makes possible the production of a complete lithographic plate in less than a minute, and reduces to a few minutes the time required to prepare a printing plate for etching. In addition, he described application of the process to the swift production of printed circuits.

The RCA Electrofax system, developed at the David Sarnoff Research Center of RCA at Princeton, N. J., produces images or printed characters on any paper, wood, metal, plastic, or other surface coated with an inexpensive photoconductive pigment. The coated surface is charged electrically before exposure to a light image by any of the conventional photographic procedures. The image is then developed with resin powder applied by a magnetic brush, and is fixed in permanent form by fusing under heat. The entire process can produce a finished permanent print in a fraction of a minute.

Describing application of the process to lithography and photoengraving, Mr. Grieg pointed out that the Electrofax system for the first time permits direct projection of an image onto the plate that is to be used in actual printing, giving the metal plate an optical sensitivity thousands of times greater than that of plates now used.

In the photoengraving application, the plate is so sensitive that it may be exposed directly in the camera used by the photoengraver, eliminating a series of steps now required to transfer a film exposure to a metal plate. An exposure of a few seconds under ordinary photoflood or fluorescent lamps is sufficient to place an image on the coated printing plate mounted in the camera. Conventional photoengraving procedures require considerably longer exposures under arc lamps to transfer an image from a previously prepared photographic transparency.

The Electrofax coating basically is sensitive only to ultraviolet and blue light. However, the addition of certain low-cost dyes extends this sensitivity into the visible light range, giving the coating, when it is charged, the same response to light as that required in photo contact printing.

Projection Magnifier Has Built-In Lighted Screen

The first project in the bioengineering field undertaken by The Franklin Institute Laboratories (FIL) was to develop a projection magnifier that would make reading as nearly normal and easy for many of the visually handicapped as it is for people with normal sight. With the announcement that mass-produced Magnifiers are now available to the public, the project comes to a highly satisfactory conclusion.

The Projection Magnifier is designed to help those who cannot read ordinary books, newspapers or letters, even with glasses. It is an optical instrument that projects a three- or five-times enlarged image of reading material on a built-in illuminated screen, where it can be read easily for prolonged periods at a normal, comfortable reading distance.

Funds furnished by the W. K. Kellogg Foundation of Battle Creek, Mich., have supported the efforts of the FIL staff through five years of research, development, and testing.

American Optical Company Photo

READER scans magazine on screen of Projection Magnifier which accommodates all types of publications: i.e., newspapers, pamphlets, books with both cloth and paper bindings.

W. E. Frank, chief of FIL's bioengineering section and H. P. Schick of the machine design and development section share honors for directing the project. The American Optical Company manufactures and markets the instrument.

Chief advantage of the Magnifier is the ease with which its handicapped users can operate it. The unit is small, light, and rugged enough to be portable, and adjusts automatically to accommodate reading material of almost any size or thickness. Illumination is provided by one inexpensive 40-watt lamp with an expected life of 1,000 hours; burned-out lamps are rare, and burned fingers from lamp heat are virtually impossible.

The Magnifier design was based on both three- and five-times enlargement, so as to be useful to the greatest number of handicapped. (Production instruments are available with either magnification.) At five-times magnification, seven lines of a newspaper column fit on the screen in full width; a Magnifier with threefold enlargement will display even more material.

By virtue of its parallelogram suspension, the upper housing remains horizontal and flat against the page regardless of the thickness of the book, which helps insure an evenly focussed image on the screen. To turn a page, the reader pushes up gently on the housing (counter-loaded to stay in any position), turns the page, then pushes the housing down again. To scan or read down a page, the reader merely moves the page as though he were viewing it through a stationary port or window. The book rest is designed to slide easily. No uncommon movements are needed since the reading material lies before the reader in the same position as it would if he were reading normally.

LETTERS TO THE EDITOR

INSTITUTE members and subscribers are invited to contribute to these columns expressions of opinion dealing with published articles, technical papers, or other subjects of general professional interest. While endeavoring to publish as many letters as possible, Electrical Engineering reserves the right to publish them in whole or in part or to reject them entirely. Statements in letters are expressly understood to be made by the writers. Publication here in no wise constitutes endorsement or recognition by the AIEE. All letters submitted for publication should be typewritten, double-spaced, not carbon copies. Any illustrations should be submitted in duplicate, one copy an inked drawing without lettering, the other lettered. Captions should be supplied for all illustrations.

Solve an Equation?

To the Editor:

The writer in the process of solving for the Power Gain of an antenna array over an Isotropic radiator, is confronted with the following integral:

$$\int_0^{\pi/2} \frac{J_0(S \sin\phi)\, \cos^2\left(\frac{\pi}{2}\cos\phi\right)}{\sin\phi}\, d\phi$$

Where: J_0 is the zero order Bessell Function of the first kind.

It is hoped that some reader may find the solution, thus filling in the gap which still exists after exhaustive investigation.

Very truly yours,

B. L. Barquist (AM '50)

(Norton Air Force Base, San Bernardino, Calif.

EDITOR'S NOTE: A hint—experts in calculus advise that this belongs to the general class of "sonine integrals."

The Struggle for Unity

The letters which follow were sent to the Editor for publication in the hope that the discussions therein would be enlightening.

Mr. Walter B. Morton
AIEE Representative on Executive
Committee of EJC
% Pennsylvania Power and Light Company
901 Hamilton Street
Allentown, Pa.

Fallacy: Federation Impotence

Dear Walter:

This acknowledges your letter of October 24, 1955, in which you transmitted to the EJC Directors your article on "The Struggle for Unity" asking that they withhold judgment on your proposal until the EJC Planning Committee has had opportunity to review the plan and make recommendations to the EJC Board.

The purpose of this letter is not to discuss your proposed plan but to point out a fallacy in your article which is too often accepted and which you disprove in your own article.

The fallacy is "the inherent weakness of any federation type organization" which you mention on page 6 of your reprint. You state: "*Any* action within EJC must be referred back to the constituent Societies' boards for concurrence before action is taken."

On page 5 you recite eight accomplishments of EJC and state that EJC in a short time performed well in meeting its objectives.

Every one of the accomplishments you appraise as noteworthy were put into action without reference to the boards of the member Societies.

At least one project came to EJC through a suggestion by the board of a member body.

You omit other EJC accomplishments all made without benefit of board reference. The Atomic Energy Panel, the National Engineers' Register, the Nuclear Congress, and the Planning Committee which you proposed, are such accomplishments.

I attended the Cleveland Nuclear Engineering and Science Congress instituted and co-ordinated by EJC. It was a great occasion with over 3,000 attending the presentation of more than 200 papers contributed under the auspices of 26 Societies. This Congress resulted from informal discussions of EJC committee members during the summer of 1954 when the need became apparent that something should be done to dramatize to the entire profession that nuclear engineering problems defy the existing disciplines. None of the succeeding actions of EJC which led to this highly successful Congress were referred to the constituent boards for approval. It is true that the success of the Congress required the support of the co-operating bodies through the proper agencies in each Society and undoubtedly the boards had cognizance of what was going on. However, as the plans were developed by EJC no detail was referred by EJC for acceptance or veto by the board of any constituent body. There was a unity of spirit demonstrated in this venture more significant and far-reaching than a unity organization on a chart.

In the same way, the dramatic story of the EJC Manpower Commission can be told. To meet an imperative need in 1950, the Commission was organized in two months; in another four months it had a permanent staff and within a year, it was operating an annual budget of $100,000. This was done without benefit of referral to Society boards and its results have been of far-reaching value to the national security and the engineering profession. It is true that some Societies advanced funds to start the Commission in business. This required individual board action but the fact still remains that the initiation of the project was made without any board action.

An important reason why EJC has been able to take quick action on pressing problems is the fact that the EJC Board is made up of Society representatives who are members of the boards of the constituent Societies. As they sit on the EJC Board, they are conscious of their responsibility to their Societies as well as their broad responsibility to the profession and they act accordingly.

Changes in the EJC Constitution and the election of new members require action by the boards of member bodies. Each board must take action to provide its quota of the EJC budget although the budget as a whole is not submitted to the boards for approval. Each board must decide whether it wishes to participate in any particular EJC program requiring financial support over and above the annual EJC budget. These processes are fundamental to EJC operation and are necessary in carrying out a useful program. They do not hamper EJC or deaden its initiative.

This letter is written in my capacity as an individual director of EJC, as your letter was written. It has the cognizance of my fellow ASME directors on EJC and of the ASME Executive Committee. On the same basis, I assume your letter and article are expressions of your personal view and not the official expression of AIEE.

I am sending you fifty (50) copies of this letter because I know that in your usual fair way of encouraging discussion you will want to send it to those who received your letter and article with any comments you may wish to make on this letter, which I will welcome heartily.

One copy of this is going to William F. Ryan, an ASME member whom you mention in your letter of October 24, 1955.

Whether you wish to forward the salient portions of this letter to *Electrical Engineering* as a discussion on your article is a question for you to decide. I do not press it.

I am making the general purport of this letter available to the ASME Sections who will discuss "unity," at the Spring Regional Administrative Committee meetings. Some of the Section officers have heard of the doctrine of the inherent impotence of federations and they are entitled to the facts.

With best wishes for your discussion program.

Sincerely,
C. E. DAVIES
(An ASME Representative on EJC)

February 8, 1956

Mr. C. E. Davies
ASME Representative on EJC
American Society of Mechanical Engineers
29 West 39th Street
New York 18, N. Y.

Dear Clarence:

Thank you very much for your letter of January 25 in which you comment on the statement in my paper "The Struggle for Unity" where I stated "Any action within EJC must be referred back to the constituent societies Boards for concurrence before action is taken." I am very pleased indeed that this is the only comment that you make on my paper and on the plan proposed. It is gratifying to know that the many other statements in the paper meet with your concurrence.

As to the statement commented on, I endeavored to point out that there are certain areas in which a federation of societies can serve the membership of the technical societies and I listed many of these in which EJC has a record of outstanding accomplishment. However, if you read further beyond the statement that you quote, you will find that I was trying to point out that a true unity society should be completely informed of the wants of its *individual members* and it should provide for effective action in line with the desires of these members, but without necessity for referring back to the constituent societies' Boards. In other words, I was pointing out that the Boards of Direction do not always represent the opinions or the desires of the individual members in matters that affect the individual members. A typical case is the matter of polling the individual members on the matter of unionization of engineers. You will recall that EJC was not in a position to obtain the necessary figures from the individual members of the technical societies without requesting this from the societies Boards. You will also recall that not all of the societies were willing to have such figures published. In this instance, the individual member had no voice whatever in the matter.

Another instance where EJC cannot act effectively for the individual member is in its persistent stand in favor of a federation of societies to represent all engineers, which stand reflects only the opinion of the officers of the various societies and does not necessarily reflect the opinion and desires of the individual members. In a true unity organization, such a decision would be made and such a stand taken only after it became clearly evident that the position taken was that desired by the majority of all the members of the profession.

I should not, of course, have used the word "any" without clarification, but the word "any" was, of course, intended to refer to actions affecting the individual member rather than the usual broad aspects such as a national water power policy, the setting up of a nuclear congress, etc., which the individual engineer is quite willing to have his elected representatives handle in the way they see fit.

You have sent me 50 copies of your letter suggesting that I send it to those who have received copies of my paper and of course I am pleased to distribute these 50 copies as far as they will go. However, there have been over 1,200 copies of my paper requested and distributed in various areas which include 250 copies to members of the ASME and 150 copies to officers of the NSPE. Since I do not have the individual addresses of all these persons, it will be rather difficult to obtain complete coverage as you suggest. If you will send me 150 more copies of your letter, I will be glad to distribute them as I can.

Since you mention that you are widely distributing your letter among your ASME

Sections, it will be appreciated if you will also include in that mailing a copy of this reply.

I am suggesting to the Editor of *Electrical Engineering* that he print your letter and my reply in the next issue of the publication.

Again, many thanks for your comment and your acceptance of the other facts that have been stated in the paper.

Sincerely yours,

WALTER B. MORTON
(AIEE Representative (Alternate) on EJC)

NEW BOOKS

The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.

ABSTRACTS OF THE LITERATURE ON SEMICONDUCTING AND LUMINESCENT MATERIALS AND THEIR APPLICATIONS. 1954 Issue. Compiled by Battelle Memorial Institute. Sponsored by the Electrochemical Society, Inc., John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y., 1955. 200 pages, 11½ by 8½ inches, spiral binding. $5. A compilation of over 750 abstracts on the properties and applications of germanium, silicon, selenium, tellurium, oxides, sulfides, and other materials. The items on each material are listed separately, and there are sections covering fluorescence and phosphorescence and general theory. The abstracts, drawn from foreign and domestic journals, are designed to give enough detail to minimize the necessity of consulting the original article.

ULTRASONIC ENGINEERING. By Alan E. Crawford. Academic Press, Inc., 125 East 23rd Street, New York 10, N. Y., 1955. 344 pages, 8½ by 5½ inches, bound. $8. The main sections of this book are devoted to applications of ultrasonics in metallurgy, chemistry, biology, and medicine, and to methods of generating ultrasonic waves by piezoelectric, magnetostriction, and electromagnetic transducers, and magnetostriction and jet generators. The opening section covering basic theory includes a chapter on cavitation, and the last chapter deals with instruments and control gear.

DIGITAL DIFFERENTIAL ANALYZERS. Part I—Elements. By George F. Forbes, 10117 Bartee Avenue, Pacoima, Calif., second edition, 1955. 48 pages, 11 by 8½ inches, paper. $5. Basic integrator mechanisms are shown for the generation of exponential, trigonometric, algebraic, and inverse trigonometric functions. Adders and servos are also discussed, and techniques for their effective use presented. Tables of pertinent number systems and their conversions are supplied in an appendix.

PRODUCTION OF HEAVY WATER. Edited by George M. Murphy, Harold C. Urey, and Isidor Kirshenbaum. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, N. Y., 1955. 394 pages, 9¼ by 6¼ inches, bound. $6.25. The first part of this volume is a report of a survey of heavy-water plants and their operation as they existed at the end of World War II. It contains descriptions of catalytic exchange-electrolytic process, water-distillation, hydrogen-distillation, and some miscellaneous processes for the isolation of heavy-water. Part two records the results of a number of pilot-plant studies of the various processes.

Le Premier CONGRÉS INTERNATIONAL DE L'AÉROELECTRONIQUE. Association pour l'Encouragement à la Recherche Aéronautique. Dunod, Paris, France, 1955. 846 pages, 11 by 7½ inches, bound. F fr. 7,500. All phases of the application of electronic equipment to aviation are dealt with in these 73 papers presented at the First International Congress on Aero-Electronics. Beginning with several papers of a general nature, the subsequent material covers applications to air navigation, communication methods, airport equipment, remote control devices, and all types of aircraft instruments. The volume also considers electronic measurements, computers for aviation research, and the materials used in electronic equipment.

ROTATING AMPLIFIERS. The Amplidyne, Metadyne, Magnicon and Magnavolt and Their Use in Control Systems. Edited by M. G. Say. George Newnes Ltd., London, 1954. 152 pages, 8½ by 5½ inches, bound. 17s.6d. This book covers the basic theory of cross-generators and the operation, construction, testing, and maintenance of the four commercial amplifiers named in the subtitle. Principles of automatic control systems are also treated briefly, and some selected applications—automatic voltage regulation, remote position control, and others—are described.

SMALL-ANGLE SCATTERING OF X RAYS. By André Guinier and Gérard Fournet. Translated by Christopher B. Walker. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y., 1955. 268 pages, 9¼ by 6 inches, bound. $7.50. This monograph, mainly for the specialist in X-ray diffraction, covers theory, experimental methods, interpretation of experimental results, and the comparison of the results of this method with results of other physical methods for measuring particle sizes. The last chapter, on applications, has been written without the use of mathematics or details of X-ray techniques so that it can be read by the nonspecialist. Applications discussed include the study of carbons, the study of heterogenetics in pure metals, and the study of age-hardening aluminum-silver and aluminum-copper alloys. Over 500 references are listed in the accompanying bibliography.

TRANSISTORS AND OTHER CRYSTAL VALVES. By T. R. Scott. Essential Books, Inc., Fairlawn, N. J., 1955. 258 pages, 8¼ by 5½ inches, bound. $7.20. A condensed treatment intended for engineers who use transistors rather than for those who design them. Developed around the central theme of crystal imperfections, the discussion covers p-n junctions, point-contact devices, operating temperatures, circuitry, high-frequency transistors, and the choice of semiconductors. Appendixes deal with the band structure of semiconductors and with techniques for testing transistors and diodes. A bibliography of 277 references is included.

200 MILES UP—The Conquest of the Upper Air. By J. Gordon Vaeth. Ronald Press Company, 15 East 26th Street, New York 10, N. Y., second edition, 1955. 261 pages, 9¼ by 6 inches, bound. $5. The author is the head of the New Weapons and Systems Division of the United States Navy Special Devices Center, Office of Naval Research. His book is an account, written for the engineer, scientist, and layman of the nature of the upper atmosphere and of the balloons, rockets, and instruments used in its exploration. This edition includes new chapters on interplanetary flight, the planned artificial earth satellite, and probable future developments in the field.

REACTOR HANDBOOK. Physics; Materials: General Properties; Engineering. United States Atomic Energy Commission. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, N. Y., 1955. 790 pages, 610 pages, 1,075 pages, 10½ by 8½ inches, bound. $12., $10.50, $15. The three large volumes of this new handbook provide an extensive source of reliable data for those working in the reactor field. The physics volume covers theoretical and experimental techniques for the design and evaluation of experimental and research reactors and includes a section on reactor-shield design. The volume on materials presents information on the availability, processing, and properties of metals and alloys, ceramics, carbides, and other solid materials used in reactor applications. The engineering volume covers the design of the various types of fluid-fuel reactors and of fixed-fuel reactors using water, liquid-metal, or gas cooling. Methods for performing remote handling and control operations are included.

PAMPHLETS

The following recently issued pamphlets may be of interest to readers of "Electrical Engineering." All inquiries should be addressed to the issuers.

Lefax Technical Data Catalogue for 1956. This newly revised free catalogue of pocket size technical data books has been published by Lefax Publishers, Philadelphia, Pa. These handy reference books cover every branch of engineering and are comprehensive as well as authoritative for engineers, technical workers, students, teachers and practical men. Each book contains approximately 140 pages of data including current advances. Lefax data books sell for $1.25 each. To receive this free catalogue write to Lefax Publishers, Philadelphia 7, Pa.

American Standard System for Straight Bevel Gears. The American Society of Mechanical Engineers, as administrative sponsor for Sectional Committee B6, has published this 9-page pamphlet, *ASA B6.13-1955*. This system for the design of straight bevel gears is a development from a system originated by the Gleason Works and adopted by the American Gear Manufacturers Association (AGMA). The text pages describe the general basis of the system and show the calculations used to obtain the tooth proportions and blank dimensions. This standard was prepared with the cooperation and approval of the AGMA Bevel Gearing Committee. It was presented to the American Standards Sectional Committee B6 on the Standardization of Gears by its Subcommittee on Straight Bevel Gears. $1. Copies may be obtained from The American Society of Mechanical Engineers, Order Department, 29 West 39th Street, New York 18, N. Y.

Some Characteristics of Image Orthicon Camera Tubes. The purpose of this report prepared by the Naval Research Laboratory (March 1955) is to formulate the general characteristics of these tubes and establish a basis for predicting their performance under abnormal operations. With greater light intensity through increased exposure time, for instance, the tube could detect the fine detail of images at twilight or dusk which the human eye cannot discern. Conversely, under brilliant lighting, exposure time might be decreased to the extent that the tube could be used to study rapid motion. 44 pp., illustrated. $1.25. This booklet, *PB111658* may be obtained from the Office of Technical Services, United States Department of Commerce, Washington 25, D. C.

Reduction of Power-Line Radio Interference. The Naval Civil Engineering Research and Evaluation Laboratory, February 1955, reports work done on an isolation filter for reduction of power-line radio interference. Construction details and subsequent tests are described, and it is concluded that, in general, it is impracticable to bury a power line in the earth as a filter. It is recommended that future work be directed toward development of a practical above-ground minimum reflection-type shield to result in a nonradiating line which does not guide radio frequency energy. 32 pp., illustrated. $1. Order *PB111666* from the Office of Technical Services, United States Department of Commerce, Washington 25, D. C.

Polyphase Motor Starting Current Rules. This report on the effect of starting currents in the problem of motor applications has been issued jointly by the Association of Edison Illuminating Companies, the Edison Electric Institute, and the National Electrical Manufacturers Association. 2 pages with tables. 25¢. Available from the Association of Edison Illuminating Companies, 51 East 42nd Street, New York, N. Y.

Basic Principles of Parliamentary Law and Protocol. This 68 page booklet can be ordered from Marguerite Grumme, 3830 Humphrey Street, St. Louis 16, Mo., at the price of $1 per copy. It gives procedures for conducting a meeting properly.

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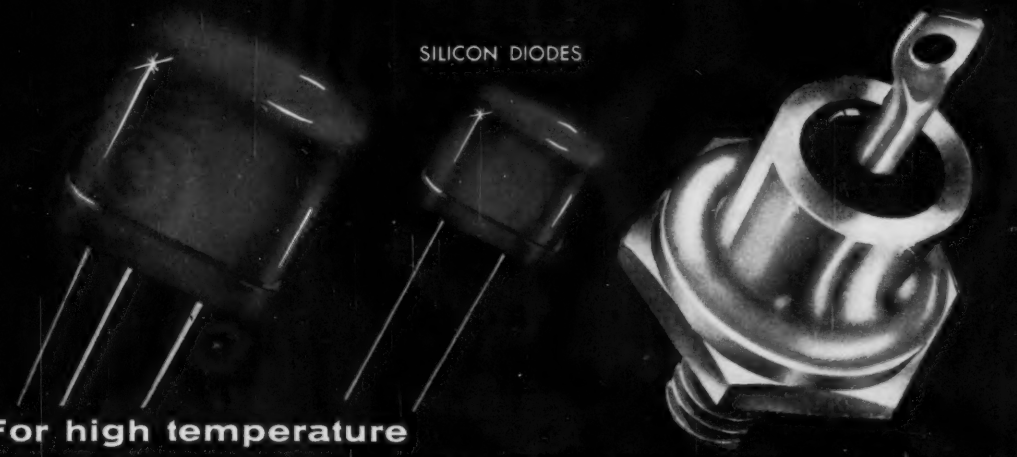

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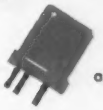

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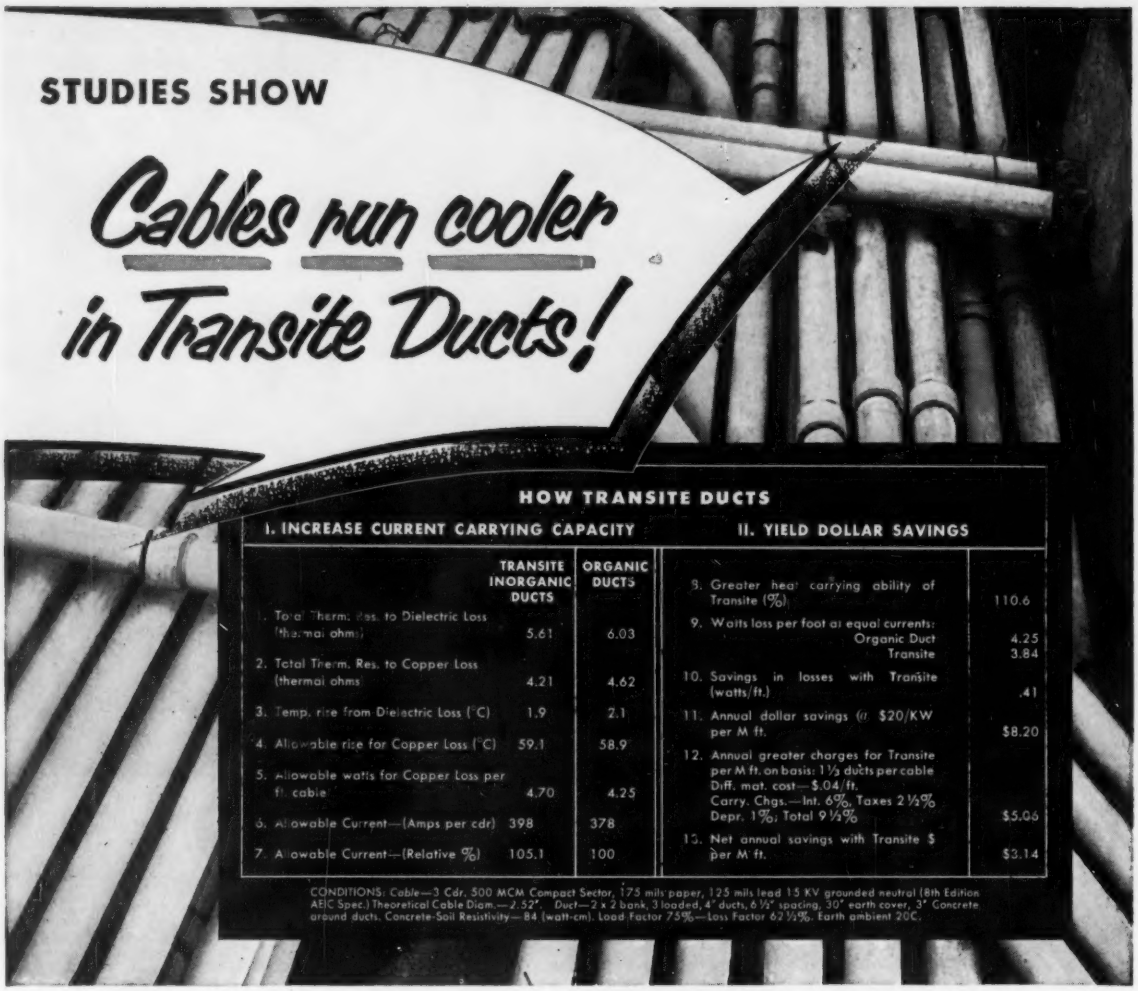

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5. Allowable watts for Copper Loss per ft. cable	4.70	4.25
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CONDITIONS: *Cable*—3 Cdr. 500 MCM Compact Sector, 175 mils paper, 125 mils lead 15 KV grounded neutral (8th Edition AEIC Spec.) Theoretical Cable Diam.—2.52". *Duct*—2 x 2 bank, 3 loaded, 4" ducts, 6½" spacing, 30" earth cover, 3" Concrete around ducts. Concrete-Soil Resistivity—84 (watt-cm). Load Factor 75%—Loss Factor 62½%. Earth ambient 20C.

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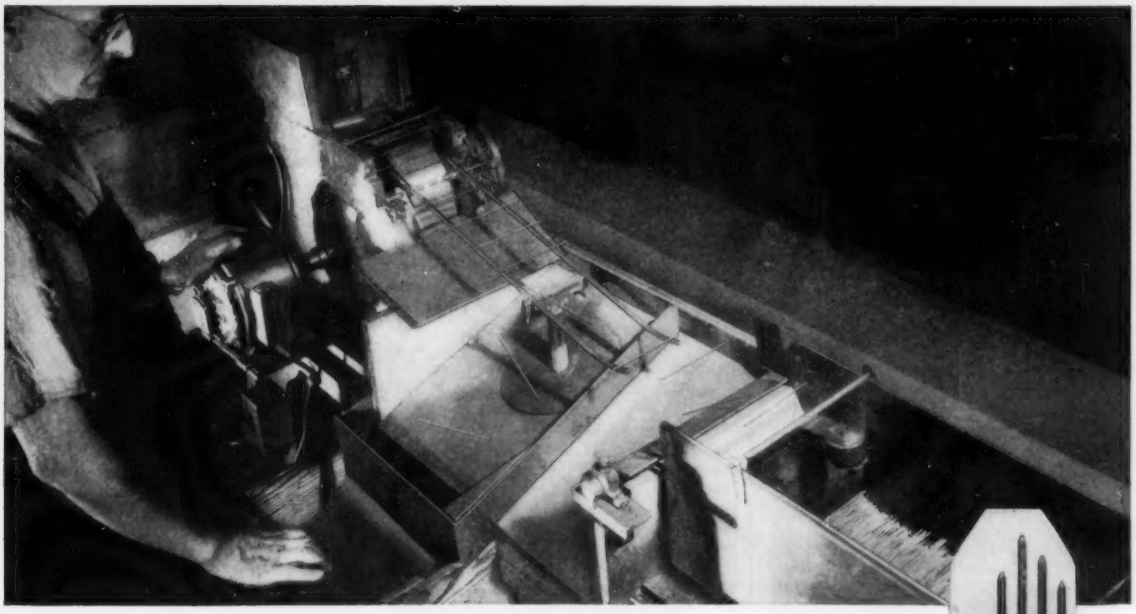

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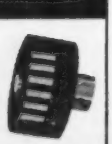

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INDUSTRIAL NOTES ...

IBM Expansion Program. Construction of major new sales, research, manufacturing, and service facilities on the Pacific Coast has been announced by the International Business Machines Corporation (IBM). Two office buildings, one in San Francisco, the other in Los Angeles, Calif.; new manufacturing, engineering, and educational facilities in San Jose, Calif.; a new office building in Santa Monica, Calif.; data processing centers in Portland and Seattle, Wash.; are all part of this program. These new facilities will provide space for IBM to carry out every phase of its varied activities.

Construction Is Planned. Plans for a $3 million addition to the military electronics engineering, research, and production facilities in Phoenix, Ariz., were revealed by Motorola, Inc. Selection of the Phoenix site conforms with the Defense Department's requirement for dispersal of military facilities.

Sprague Transistor Plant. Construction of a plant to manufacture surface-barrier transistors will begin shortly at Concord, N. H., by the Sprague Electric Company. General manager of Sprague's Concord operations will be Jesse Ault, who recently retired as works manager of the Haverhill and Andover, Mass., plants of the Western Electric Company. John Puppolo, who has been associated with the Sprague Electric Company for the past 22 years and is presently production superintendent of the firm's tantalum electrolytic operations at North Adams, Mass., will be factory manager in charge of production. The Concord plant will be Sprague's twelfth for the manufacture of electronic components.

RCA Completes Conversion for Production of Color TV Receivers. Industry's first plant completely converted for and geared to the mass production of color television receivers has been announced by the Radio Corporation of America (RCA). The company is now geared to produce, on each of three lines, a color television set—completely tested, packed, and ready for shipment—every 60 seconds.

Southern California Edison To Produce Electricity from Atomic Energy. The Atomic Energy Commission has authorized Atomics International, a division of North American Aviation, Inc., and the Southern California Edison Company to negotiate a contract in connection with the Atomics International experimental reactor near Santa Susana, Calif. With this authorization, the Edison Company can proceed with its plans for installation and operation of generating equipment there which will produce electrical energy from the heat developed by the reactor.

Canadian Lighting Bureau Formed. Decision to form a Canadian Lighting Bureau was made at a special meeting of 45 Canadian lamp and fixture manufacturers held in Toronto, Ont., Canada, on January 16, 1956. The main object of the proposed Bureau will be to promote better lighting, with the aim of increasing the Canadian market for lighting equipment. Chairman of the meeting was B. A. Wilson, vice-president, J. A. Wilson Lighting and Display Limited, Toronto, Ont., Canada, who explained that the Bureau would attempt to correlate, in Canada, activities now being carried on by the three main groups promoting lighting in the United States. These are the National Lighting Bureau, the American Home Lighting Institute, and the Edison Electric Institute. Reason for the exploratory meeting was to determine whether Canadian lighting equipment manufacturers would be willing to support a Canadian Lighting Bureau. The representatives attending the meeting were wholeheartedly in favor of the recommendation, and authorized the appointment of an Organizational Committee to establish the Bureau and to recruit members from companies engaged in the lighting field.

New Product Development by Clark. By an agreement with Ruston and Hornsby, Ltd., of Lincoln, England, Clark Brothers Company, of Olean, N. Y., one of the Dresser Industries, will begin manufacture in the United States of the Markta gas turbine. The turbine develops 1,300 hp, and will have wide industrial applications, both as a prime mover for utilities, and as a unit for general industry. This is the first time that a British product will have been manufactured by a Dresser company in the United States, although many Dresser products or patents are manufactured in Britain by various licensees.

General Electric Forms Subsidiary Corporation. The Trumbull components department of the General Electric Company has announced the formation of a subsidiary corporation, Caribe General Electric, Inc., to operate a plant in Palmer, Puerto Rico, for the manufacture of low-voltage electrical distribution protective and disconnect devices.

Particle Accelerator To Be Built. The design and development by Argonne National Laboratory of a multibillion volt particle accelerator to be built at its DuPage County site Lemont, Ill., was authorized by the United States Atomic Energy Commission. The Argonne machine, based on a design conceived by the Laboratory's staff of scientists, will greatly ease the usual problems of construction. It permits the rapid attainment at reasonable cost of an energy vastly in excess of that of any machine now in operation. It is expected that the Laboratory also will

(*Continued on page 24A*)

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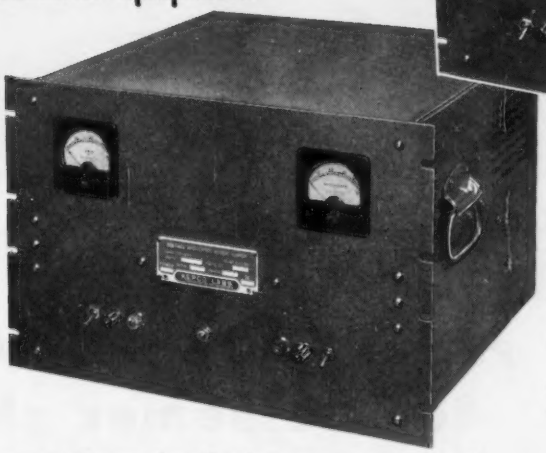

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Try them on your splices—write for a free box of 4 sample tapes to The Okonite Company, EG Tape Department, Passaic, N. J.

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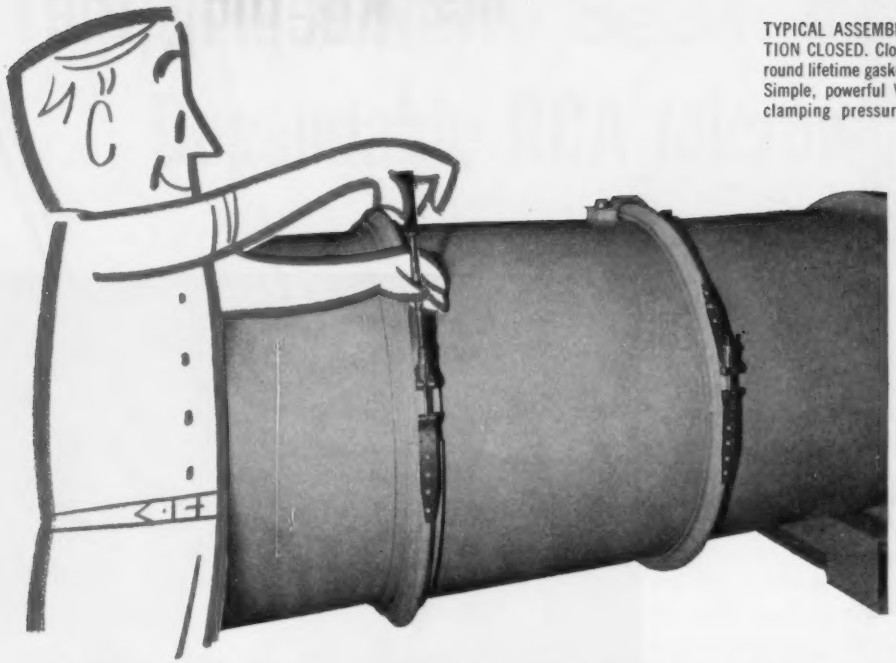
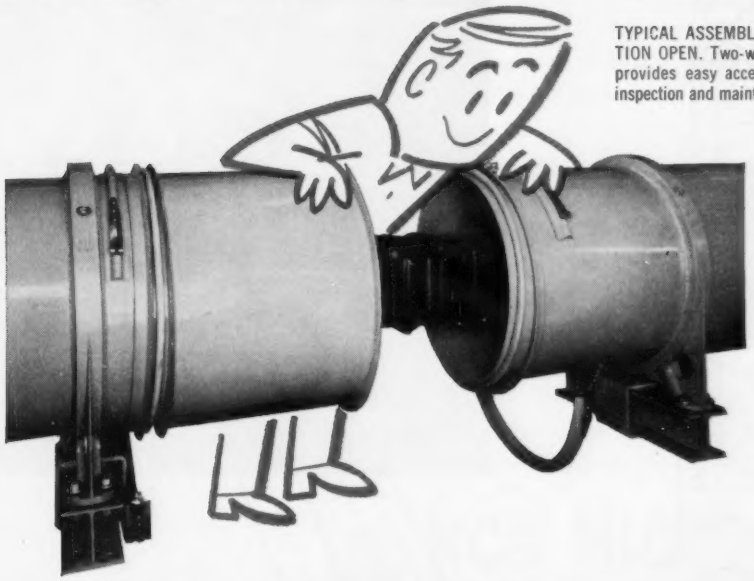
OKONITE **splicing tapes**

3522



TYPICAL ASSEMBLY WITH TELESCOPING SECTION CLOSED. Closure requires only two 1-piece round lifetime gaskets—easy to place and remove. Simple, powerful V-clamp couplings distribute clamping pressure uniformly around the ring.

New design of I-T-E Isolated Phase Bus



TYPICAL ASSEMBLY WITH TELESCOPING SECTION OPEN. Two-way sliding telescoping section provides easy access to connectors—simplifies inspection and maintenance.

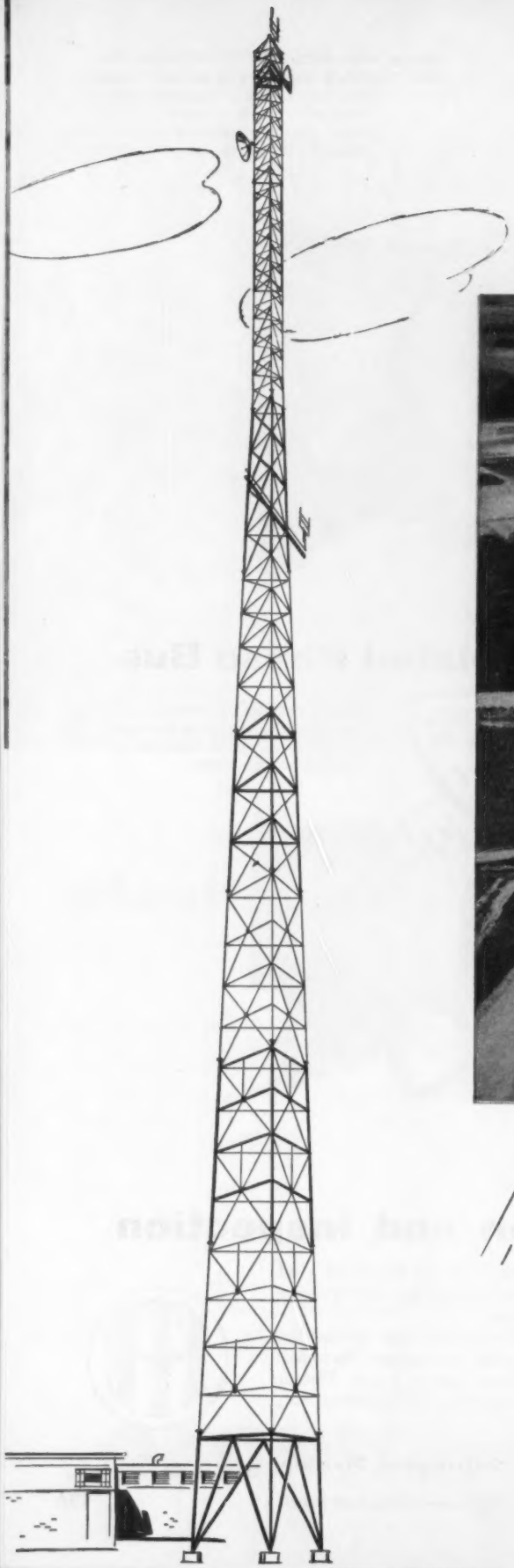
simplifies installation and inspection

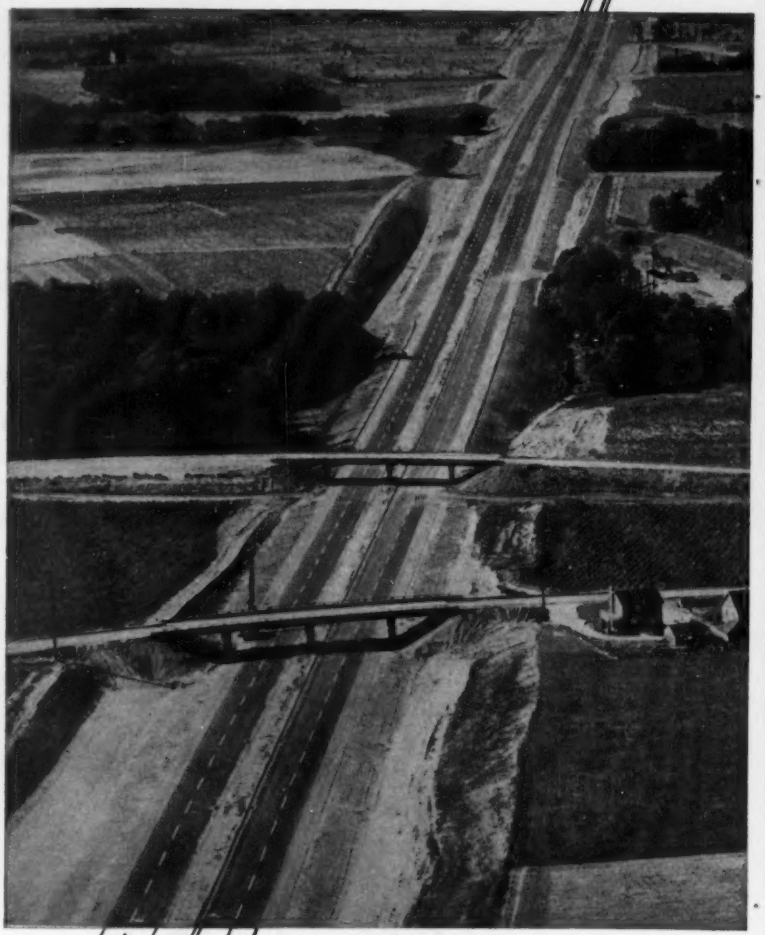
All-welded aluminum basic assemblies—joined together with 2-way sliding telescoping sections—cut installation and inspection time. A V-clamp closure and a 1-piece round gasket in each telescoping section joint assure a permanently tight seal. This new design reduces gasketing 75%. In addition, it combines great strength and light weight with structural simplicity. And smooth inside surfaces prevent the accumulation of moisture.

Bulletins 10004-A and 10004-B describe I-T-E Isolated Phase Bus designs. For copies of these bulletins, write I-T-E Circuit Breaker Company, 19th and Hamilton Sts., Phila. 30, Pa.

I-T-E CIRCUIT BREAKER COMPANY • Switchgear Division

Keeping the





...with RCA 2-Way Radio

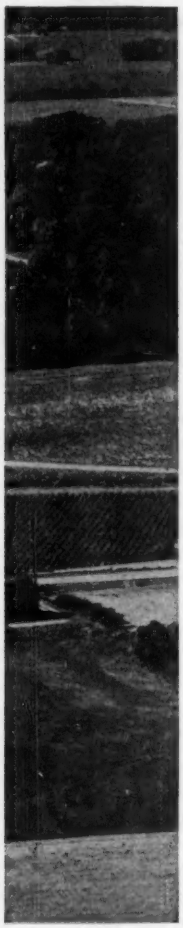
RCA®

RADIO CORPORATION of AMERICA

Communications Products

CAMDEN, N.J.

Turnpikes *on the beam* means Dependable RCA Microwave



Those high towers you see as you drive along the great turnpikes usually mean that RCA Microwave is on the job providing instant and continuous communication. On the Pennsylvania Turnpike, the New Jersey Turnpike, the Ohio Turnpike . . . wherever the ultimate in dependable communications is required, RCA's performance record, in applications pitted against the toughest service conditions, tells the story of fine performance. A narrow radio beam passing from tower to tower transmits the human voice and operates control circuits. It will carry voice circuits, facsimile, teletype, telemetering, traffic information—all without the weather hazard interruptions, maintenance costs and right-of-way problems of wire lines.

ON PIPELINES—In the petroleum and natural gas industries, where pipelines knife across the country, RCA Microwave Systems link control points and unattended remotely operated booster stations. Pipe line capacity is increased and operating costs are cut. VHF control channels allow immediate contact with maintenance personnel.

IN UTILITIES—In electric utilities, RCA Microwave provides remote supervisory control of substations, load control, and telemetering of voltage and current . . . with 2-way voice channels providing communications between plant and switching stations.

RCA MICROWAVE provides the most advanced engineering features. Provision for the addition of future channels makes it the least expensive form of communication per channel mile. Equipment uses easy-to-service, familiar circuits and readily available tubes. Single side-band suppressed-carrier frequency-division multiplex is used exclusively to meet high standards of dependability. Frequency throughout the entire system is controlled at the terminals only. And only two frequencies are usually required. Furthermore, RCA provides the nationwide services of the RCA Service Company to keep your system operating at its peak.

RCA Microwave Specialists with years of microwave experience will be glad to answer any questions and to assist in planning your installation. Mail coupon for further particulars.

RCA MICROWAVE can interconnect with mobile radio installations as well as with existing telephone lines and switchboards. Patrol and maintenance units can be immediately contacted while driving along the road, saving parking and back-tracking time and preventing costly delays.

RCA MICROWAVE

POINT-TO-POINT COMMUNICATION

Radio Corporation of America
Communications Products, Dept. D-42
Building 15-1, Camden, N.J.

☐ Please send me latest literature on RCA Microwave.

Name_____ Title_____

Company_____

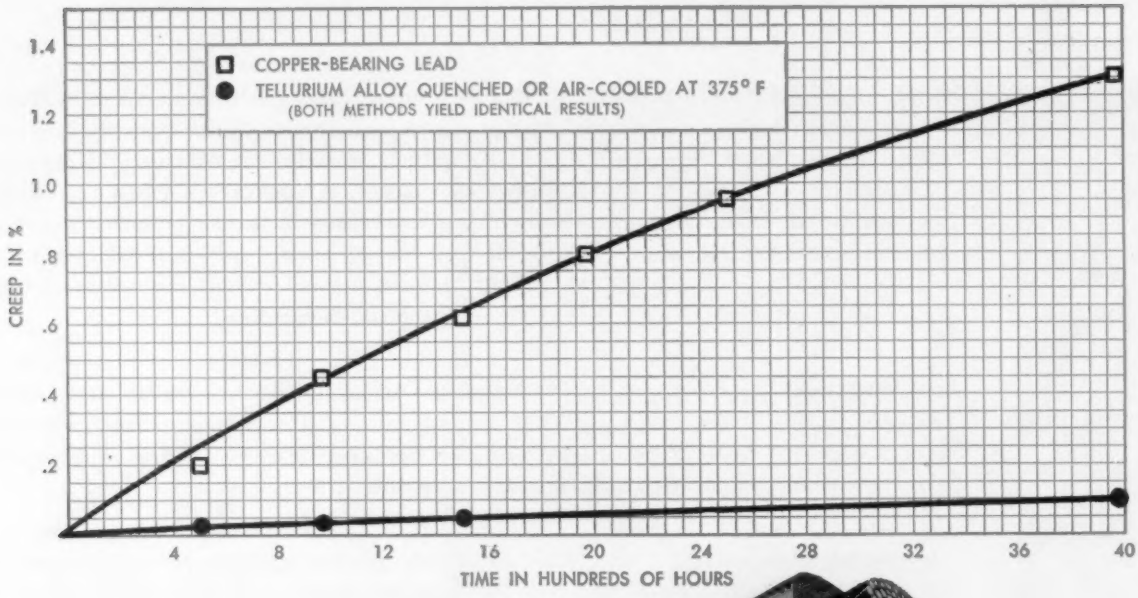
Address_____

City_____ Zone____ State_____

☐ Have RCA representative get in touch with me.

ROEBLING PAPER POWER CABLE WITH TELLURIUM LEAD ALLOY SHEATH

CREEP OF TELLURIUM LEAD ALLOY AND OF COPPER-BEARING LEAD AT 200 PSI - 150° F



TELLURIUM LEAD ALLOY HAS ONLY 1/10 THE CREEP RATE OF COPPER-BEARING LEAD

ROEBLING ELECTRICAL WIRES AND CABLES ARE AVAILABLE WITH EITHER COPPER OR ALUMINUM CONDUCTORS

THE ABOVE GRAPH illustrates one big reason why power cable with Roebling tellurium lead alloy sheath is vastly more dependable and long-lived than cable with ordinary lead sheathing. But besides its low long-time creep rate, tellurium lead alloy has every other characteristic essential for meeting today's load and temperature requirements... extra fatigue resistance... high bursting strength... *top stability under heat.* Write for full facts about this new development—the most important sheath improvement in years.

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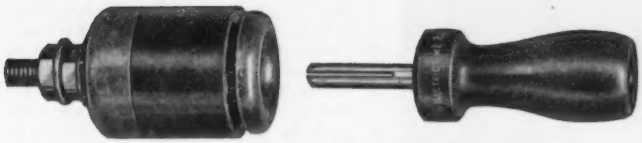
Subsidiary of The Colorado Fuel and Iron Corporation

JOHN A. ROEBLING'S SONS CORPORATION, TRENTON 2, N. J. BRANCHES: ATLANTA, 934 AVON AVE. • BOSTON, 11-15 STILLING ST. • CHICAGO, 5525 W. ROOSEVELT RD. • CINCINNATI, 3253 FREDONIA AVE. • CLEVELAND, 13235 LAKEWOOD HEIGHTS BLVD. • DENVER, 4801 JACKSON ST. • DETROIT, 918 FISHER BLDG. • HOUSTON, 6316 NAVIGATION BLVD. • LOS ANGELES, 5340 E. HARBOR ST. • NEW YORK, 19 RECTOR ST. • ODESSA, TEXAS, 1920 E. 2ND ST. • PHILADELPHIA, 230 VINE ST. • PITTSBURGH, 1723 HENRY W. OLIVER BLDG. • SAN FRANCISCO, 1740 17TH ST. • SEATTLE, 900 1ST AVE. S. • TULSA, 321 N. CHEYENNE ST. • EXPORT SALES OFFICE, 19 RECTOR ST., NEW YORK 6, N. Y.

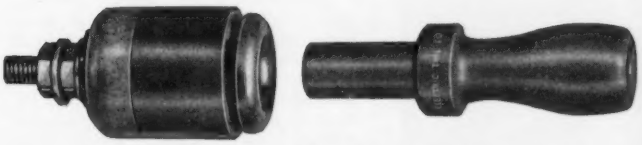
Quick-Flexible
Plug-in Connections for Power Distribution

RECEPTACLES and PLUGS by Standard



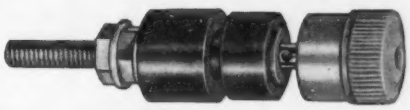
SOCKET RECEPTACLE & PIN PLUG

Sizes from 10 to 250 Ampere Capacity. Receptacle Cap in 14 colors — Plug handles in red or black.



PIN RECEPTACLE & SOCKET PLUG

Sizes from 25 to 250 Ampere Capacity. Receptacle Cap in 14 colors — Plug handles in red or black.



BINDING POSTS

Dead Front — Designed to bind spade lugs, solid or stranded wires. Accommodates standard banana plugs, and Plug Binding Post for stacking multiple connections. Sizes to 500 Ampere Capacity.

**Flexlab is the registered trade name for custom built laboratory panels and test equipment made by the Standard Electric Time Company.*

The most complete line of panelboard connectors

Plug-in connections for test or production equipment are safe and sure with Flexlab Receptacles and Plugs. Widely used for over thirty years by industry, government, schools and universities in

flexlab*

- **Power Supply & Distribution Panels**
- **Production Test Benches**
- **Laboratory Test Apparatus**

Flexlab Receptacles, Plugs and Binding Posts have been continuously improved in step with the rapid advances in the science of power switching and distribution. When designing or buying your next panel equipment be sure to specify Flexlab Receptacles, Plugs and Binding Posts.

NEW 1956 CATALOG

Contains complete details for specifying or ordering Flexlab Receptacles and Plugs, Binding Posts.

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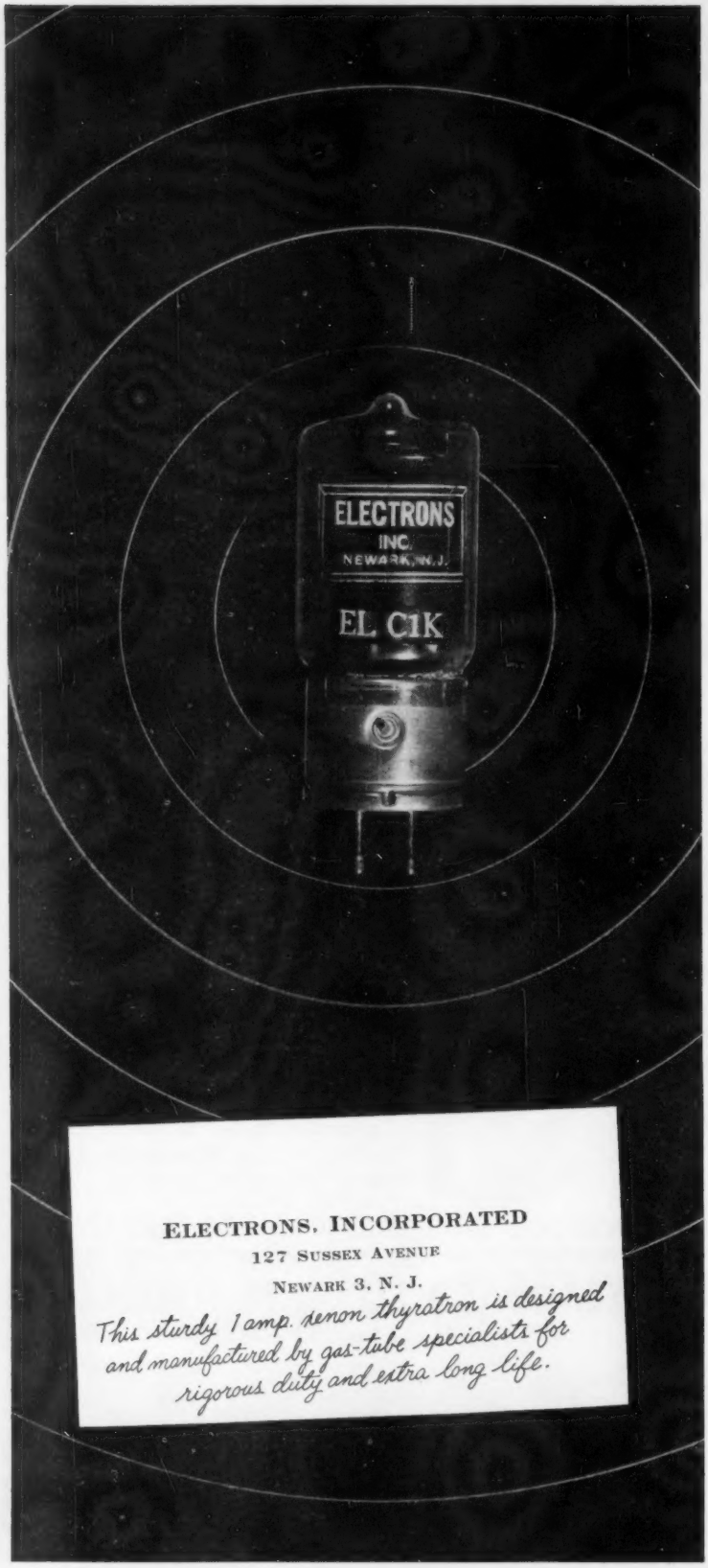
☐ *Please have engineer call to discuss specific requirements — no obligation.*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127 SUSSEX AVENUE
NEWARK 3, N. J.
This sturdy 1 amp. xenon thyratron is designed and manufactured by gas-tube specialists for rigorous duty and extra long life.

Industrial Notes

(Continued from page 16A)

make innovations in the area of accelerator design and construction and will provide its own and other interested scientists with a research tool of unexcelled power for work in the fundamental nature of atomic energy.

Communication System. Multiplexing equipment for a private commercial microwave communication system in Canada will be supplied by Stromberg-Carlson, a division of General Dynamics Corporation. The communication system is being built for the Quebec Hydro Electric Commission, by the RCA Victor Company, of Montreal, Que., Canada. Arrangements for use of the Stromberg-Carlson multiplexing equipment in the system were made by Hackbusch Electronics Ltd., of Toronto, Ont., Canada.

Vitro Corporation Obtains Foreign Nuclear Contract. Vitro Engineering Division has announced that it has obtained a preliminary study contract from the Government of India for a large heavy water and nitrogen fertilizer plant to be built in the Bhakra-Nangal area of north India on the Sutlej River. It is the corporation's first foreign nuclear contract. A team of Vitro representatives returned after six weeks of consultation with Indian authorities and reported that they have been requested to submit a complete report on production and process methods. The multimillion dollar plant will be part of an extensive development now taking place in the area. The heavy water to be produced is a key material in the nuclear power and research program planned by the Indian Government.

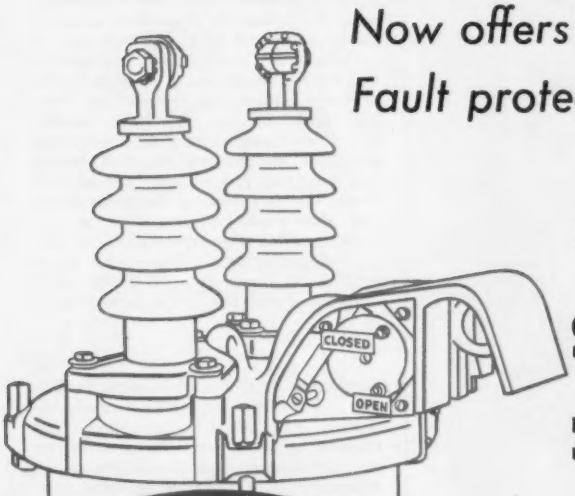
New Power Plant. A modern power plant is ready to serve a new industry rapidly being completed at Silver Bay, Minn., on Lake Superior's north shore. Built by Reserve Mining Company in conjunction with its taconite processing project, the plant will provide power for the E. W. Davis Works as well as for Reserve's other commercial processing plant located at Babbitt, Minn. A 50,000 kw turbine generator, operated under 30 pounds of hydrogen pressure, will provide the 100 kwhr required for every ton of iron ore pellets produced from taconite. The E. W. Davis Works has a rated capacity of 3¾ million tons of iron ore pellets annually, while the Babbitt plant has an annual rated capacity of 300,000 tons. Begun two years ago, and designed for an ultimate capacity of 150,000 kilowatts, the power plant incorporates modern developments in power generation. Hydrogen, circulated through the generator coils, serves as a cooling agent. Because of its lightweight and greater cooling ability, hydrogen allows increased generating capacity.

First RCA "Ampliphase" Transmitter to be Installed. Purchase by station WINS, New York, N. Y., of the first production

(Continued on page 26A)

R&IE Type MB-2 .. the All New AUTOMATIC CIRCUIT RECLOSER

Now offers much greater Temporary Fault protection - 3 exclusive ways —



1 **FASTEST INTERRUPTION** of any Recloser—1 cycle

2 **FASTEST RESTORATION** of any Recloser—20 cycles

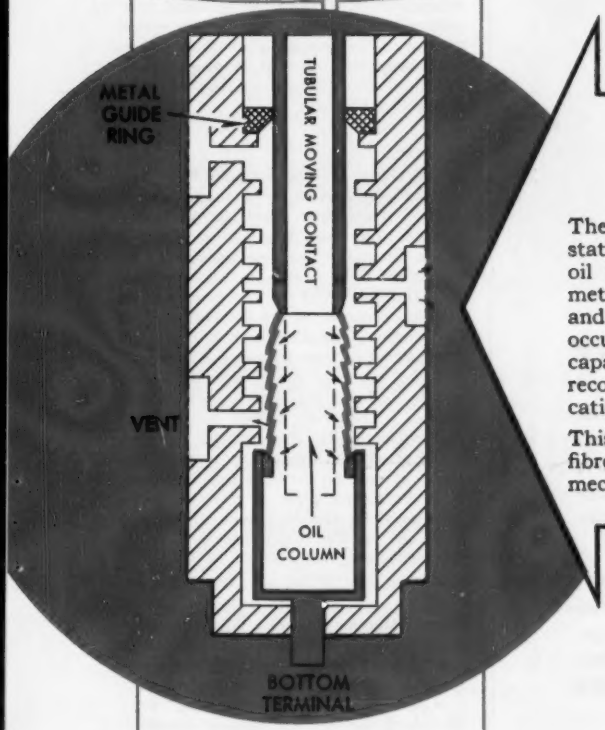
3 **NEW INTERRUPTION PRINCIPLE**—the

SC-OC

SINGLE CONTACT—OIL COLUMN

The Single, Tubular Contact, during operation, moves off the stationary Column of Oil, progressively exposing cool, clean oil to the area where arcing occurs. This arc-quenching method, in conjunction with the interrupting pressure chamber and the radial vents, is so highly effective that interruption occurs in the first half-cycle. Tests prove that it is more than capable of handling both high and low fault currents, and the recovery voltages encountered in any of its intended applications.

This new interrupting principle requires no fibre-to-metal or fibre-to-fibre assemblies—thus eliminating any possibility of mechanical interference resulting from moisture-swollen fibre.



INTERRUPTER CHAMBER SECTIONAL VIEW

Showing tubular moving contact at half way point in operating travel—arc is at highest intensity, about to separate.

Interrupting Capacities

Continuous Current Rating—Amperes	Amperes, RMS Symmetrical at System Voltages of— 4.8 Kv.	7.2 & 14.4 Kv.
100	6000	4000
140	6000	4000
200	6000	4000
280	6000	4000

Write for Bulletin No. 1550B

●

R&IE EQUIPMENT DIVISION

I-T-E Circuit Breaker Co.

GREENSBURG, PENNA.

STRUCTURES—steel or aluminum ● TESTING DEVICES ● KIRK KEY INTERLOCK SYSTEMS ● ISOLATED PHASE BUS STRUCTURES ● INTERRUPTER SWITCHES

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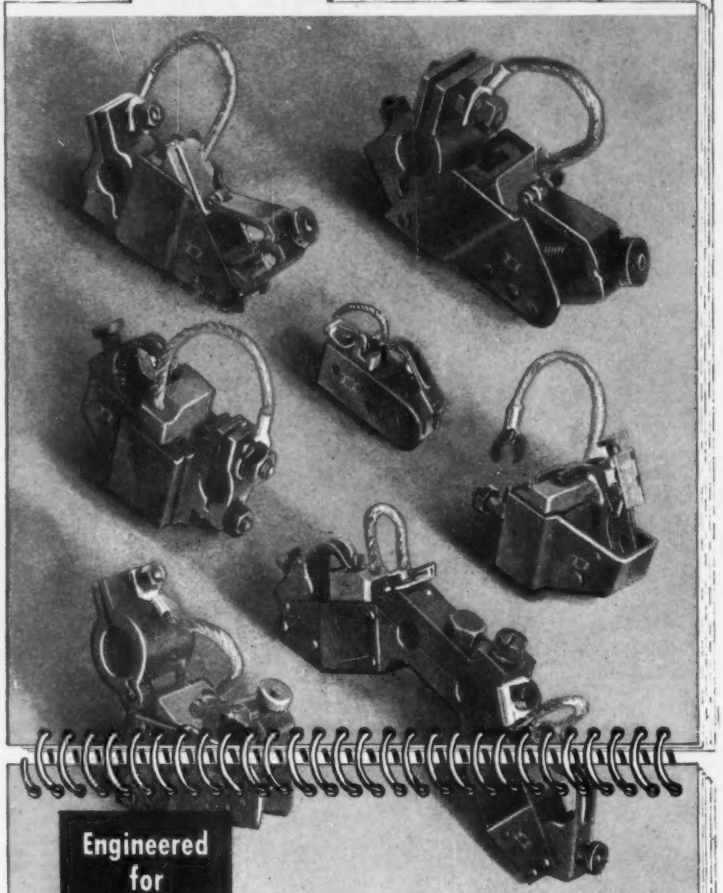
BRUSH-HOLDERS | CONTACTS | CURRENT COLLECTORS | VOLTAGE REGULATOR PILES



Engineered for better brush performance ...with MORGANITE

Selecting the right brush grade is no more important than the selection of a well-designed, well-made brush-holder. Actually, the problem of satisfactory brush operation is largely the mechanical problem of maintaining intimate contact between the brush and the commutator. *And Morganite brush-holders are engineered to do just that.*

Morganite brush-holders are the result of exhaustive investigation and tests. Every technical superiority discovered during these tests have been incorporated into their design. Our engineers will be glad to give you the benefit of their long experience in this field. Simply write us, giving all the facts you can.

50th ANNIVERSARY TRADE MARK 1906 · 1956

Morganite INCORPORATED

Manufacturers of fine carbon-graphite products for fifty years.
3308 48th Avenue, Long Island City 1, New York

Industrial Notes

(*Continued from page 24A*)

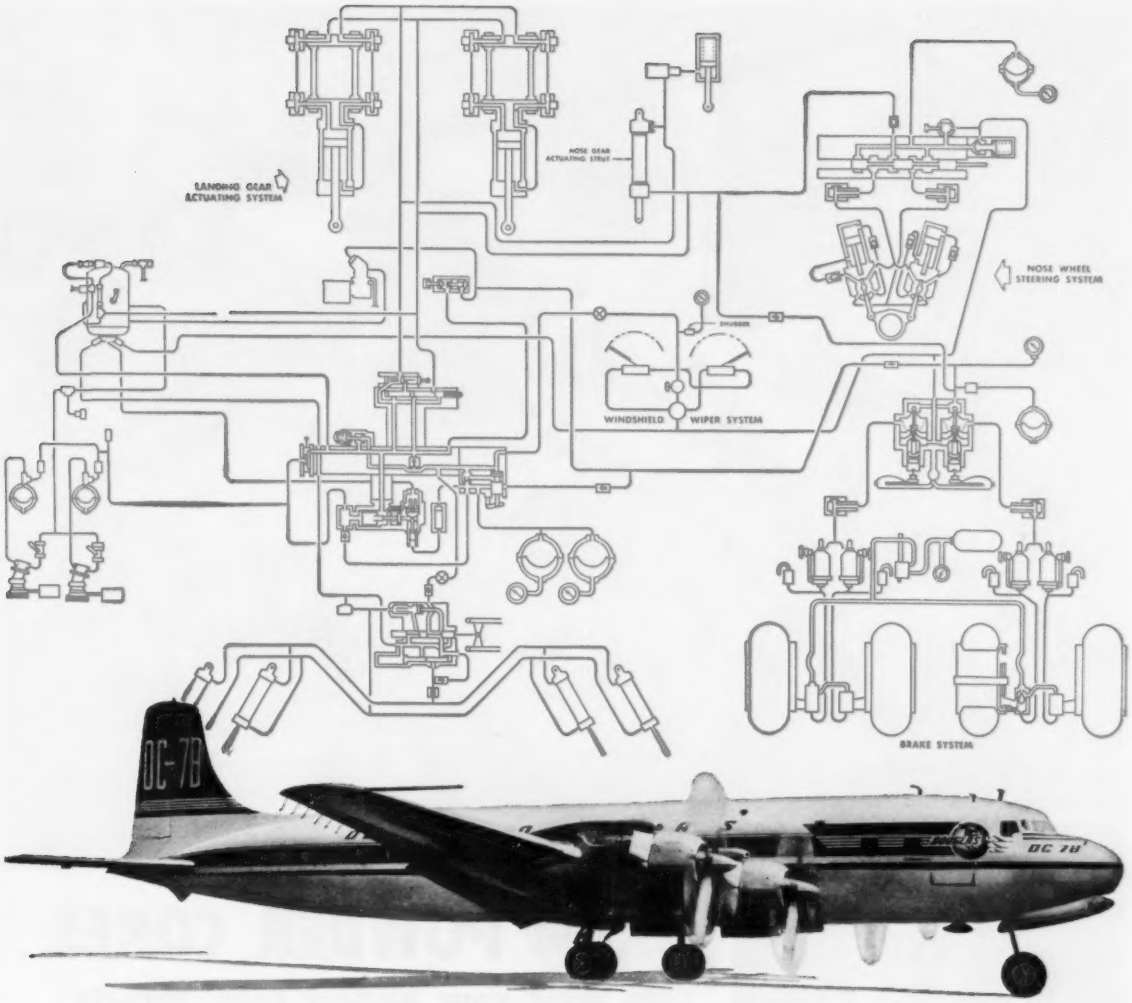
model of an RCA-developed AM radio transmitter that is expected to reduce broadcast operating costs by 50 per cent has been announced. The new transmitter, a 50-kw maximum-power type known as "Ampliphase," matches the output of appreciably larger AM transmitters with only a fraction of normally required audio power and with approximately 50 per cent fewer power tubes, components, and accessory equipment. Station WINS, a 50,000 watt station, operates on a frequency of 1,010 kc. The RCA "Ampliphase" equipment uses phase modulation principles to produce standard broadcast amplitude modulation. Special electronic circuitry enables the transmitter's two phase-modulated amplifiers to produce a combined power equal to the output of conventional 50-kw AM transmitters. It can produce 50 kw of modulated signal with only a few watts of audio power.

General Electric Installs Computer Section. The General Electric Company has entered the industrial computer field through a broadening of its computer activities from specialized engineering and military lines. The move included integration of the company's computer operations with the establishment of an Industrial Computer Section at Electronics Park, Syracuse, N. Y., headquarters of their Electronics Division.

Appalachian Electric Expands. Plans for the construction of a major steam-electric generating plant in southwest Virginia by the Appalachian Electric Power Company has been announced by the parent firm, American Gas and Electric Company (AGE). The plant will be built on property of the Clinchfield Coal Corporation. Clinchfield has set aside 40-million tons from its reserves, to supply coal for the new plant over a 30-year period under its contract with Appalachian. The power station, to be known as the Clinch River Plant, will have an initial generating capacity of 450,000 kw, and will cost an estimated $55 million. It is the second plant of this size to be announced for the AGE system, and will be located on the Clinch River at Carbo, Russell County, Va.

Cloud Behavior Studies. A better understanding of cloud behavior is expected to result from a newly developed high-speed electronic device. The instrument called a Cloud Particle Counter, has been developed for the Geophysics Research Directorate of the United States Air Force by Armour Research Foundation of Illinois Institute of Technology, Chicago, Ill. The device automatically samples and measures the minute moisture particles of which clouds are formed, according to Dr. E. H. Schulz, assistant director for research operations at the Foundation.

(*Continued on page 35A*)



Enjay Butyl rubber— vital artery in newest airliners

Douglas chooses Enjay Butyl for rubber components of the hydraulic systems in many of its famous DC-7 airliners. These components, which help assure the dependable operation of everything from wing flaps to landing gear, are proving over millions of air miles their durability and resistance to wear.

Versatile Enjay Butyl rubber may well have a place in *your* operation. It will pay you to investigate the many technical advantages it has over other types of rubber. Its price and ready availability are advantages, too. For full information, and for technical assistance in the uses of Enjay Butyl, contact the Enjay Company today.

ENJAY BUTYL

ENJAY *Pioneer in Petrochemicals*

ENJAY COMPANY, INC., 15 West 51st Street, New York 19, N. Y.

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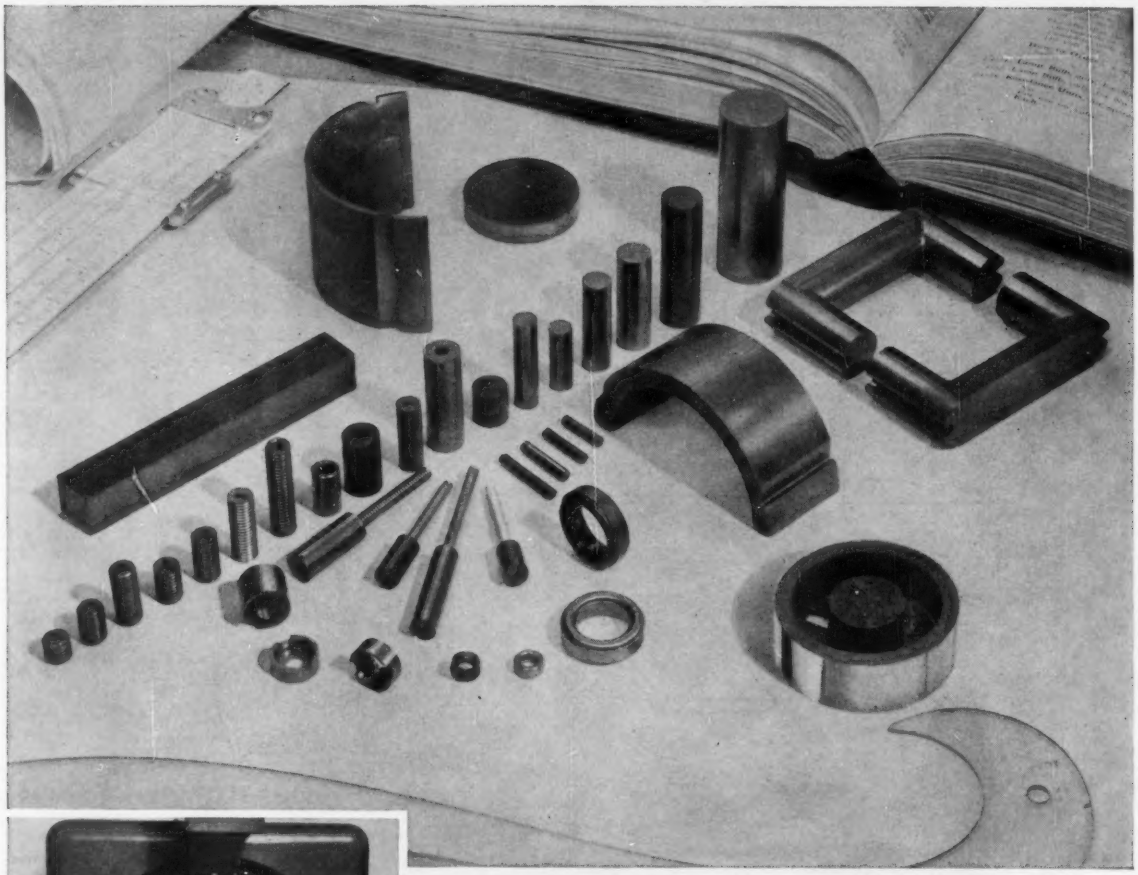
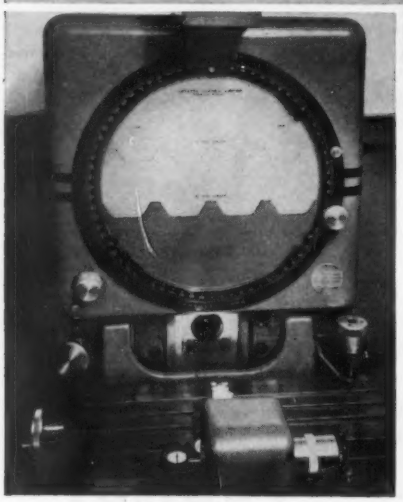
Enjay Butyl is the super-durable rubber with *outstanding* resistance to aging • abrasion • tear • chipping • cracking • ozone and corona • chemicals • gases • heat • cold • sunlight • moisture.





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to insure precision parts

Threaded cores are checked on an optical comparator at 100-x magnification to assure exact conformance. Arnold quality control of iron powder cores includes the maintaining of rigid electrical, physical and dimensional specifications unmatched in the industry.

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Contains essential data on processing, control methods, applications, types, sizes, suggested use frequencies, etc. of Arnold iron powder cores.

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Here are the essential facts to keep in mind about iron powder cores—and Arnold. As illustrated above, we make a wide selection of cores, from simple cylinders to special cores of complicated design. That includes all standard types and sizes of threaded cores, cup, sleeve, slug and cylindrical insert cores you may require: for use in antenna and RF coils, oscillator coils, IF coils, perm tuning, FM coils, television RF coils, noise filter coils, induction heating and bombarder coils, and other low frequency applications. Also, a standard series of iron powder toroids is being engineered at this time, which will conform to the standard sizes proposed by the Metal Powder Association. • We'll appreciate the opportunity to supply your needs . . . *let us quote on your requirements.*

WSW 6044

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STACKPOLE
FOUNDED 1906

Announcing a BIG IMPROVEMENT

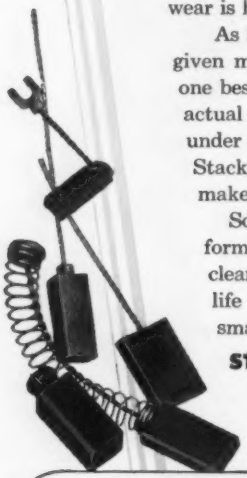
IN SMALL MOTOR BRUSHES

Exhaustive tests indicate that Stackpole Grade 373 fractional horsepower motor brushes represent a major development in their field. On vacuum cleaners, food mixers, sewing machines, calculators, and similar equipment, these new brushes have shown *materially* longer life, usually with better performance than any previous grades. Commutator wear is held to a minimum.

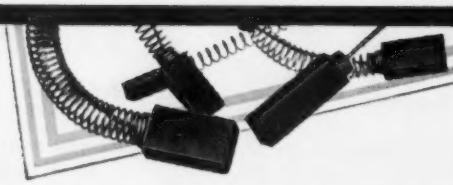
As always in applying brushes to any given motorized equipment, however, the one best way is to test them fully on that actual equipment and as close to possible under its typical operating conditions. Stackpole welcomes the opportunity to make or to facilitate such a test for you.

Solely on this basis of positive performance proof, it now becomes pretty clear that Grade 373 brushes will set new life and performance standards for small motors in a wide diversity of uses.

STACKPOLE CARBON COMPANY,
St. Mary's, Pa.



STACKPOLE
Grade 373
FAR LONGER BRUSH LIFE - *Plus*
EQUAL (OR BETTER) PERFORMANCE THAN PREVIOUS GRADES



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OPENS THE DOOR TO PROGRESS IN ELECTRONICS

Do you know that Bismuth Wire is now made commercially?

Bismuth Wire

1. Changes resistance within magnetic fields of different intensities.
2. Resistance varies in a straight line with Gauss pressure.
3. Changes from 3 to 90 times its normal resistance depending on temperature and Gauss pressure.

Bismuth Wire offers possibilities to you. Write for information.

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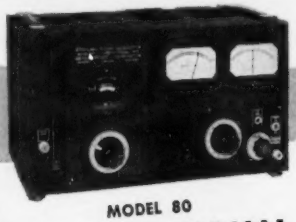
Muskegon, Michigan



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STANDARD SIGNAL GENERATOR
2 Mc to 400 Mc
Individually calibrated Direct Reading Scales and Dials

A completely self-contained instrument with built-in power supply and modulator—provides accurate test signals for testing varied radio and television equipment; for laboratory work, production testing, and servicing.

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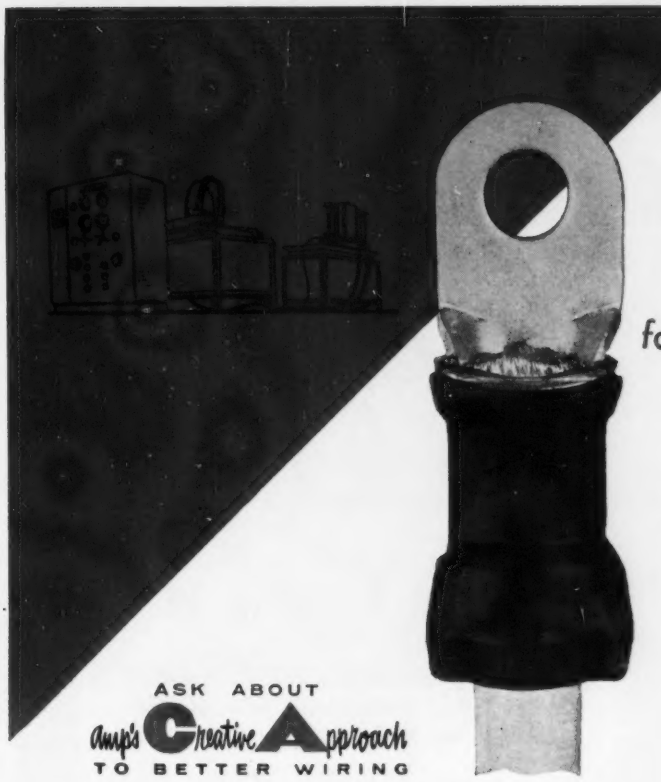

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PRE-INSULATED TERMINALS

for heavy-duty wires!

Ampli-Bond is the first and only terminal with bonded insulation and insulation support for copper wire sizes 8 through 4/0.

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Amp's Creative Approach
TO BETTER WIRING

Bonded insulation, withstanding a minimum of 6000 volts, insures dielectric value.... An insulated metal reinforcing ring grips the insulation and protects the wire from the weakening effects of vibration and bending.... The terminal body is electro-tinned for high conductivity, and the dimpled inner barrel increases the contact surface and tensile strength. . . . Assures low millivolt drop.

The A-MP Dyna-Crimp Tool, with interchangeable heads and dies, crimps Ampli-Bond terminals rapidly, easily and uniformly.

Consult your local A-MP Sales Engineer or write to Harrisburg for further information.

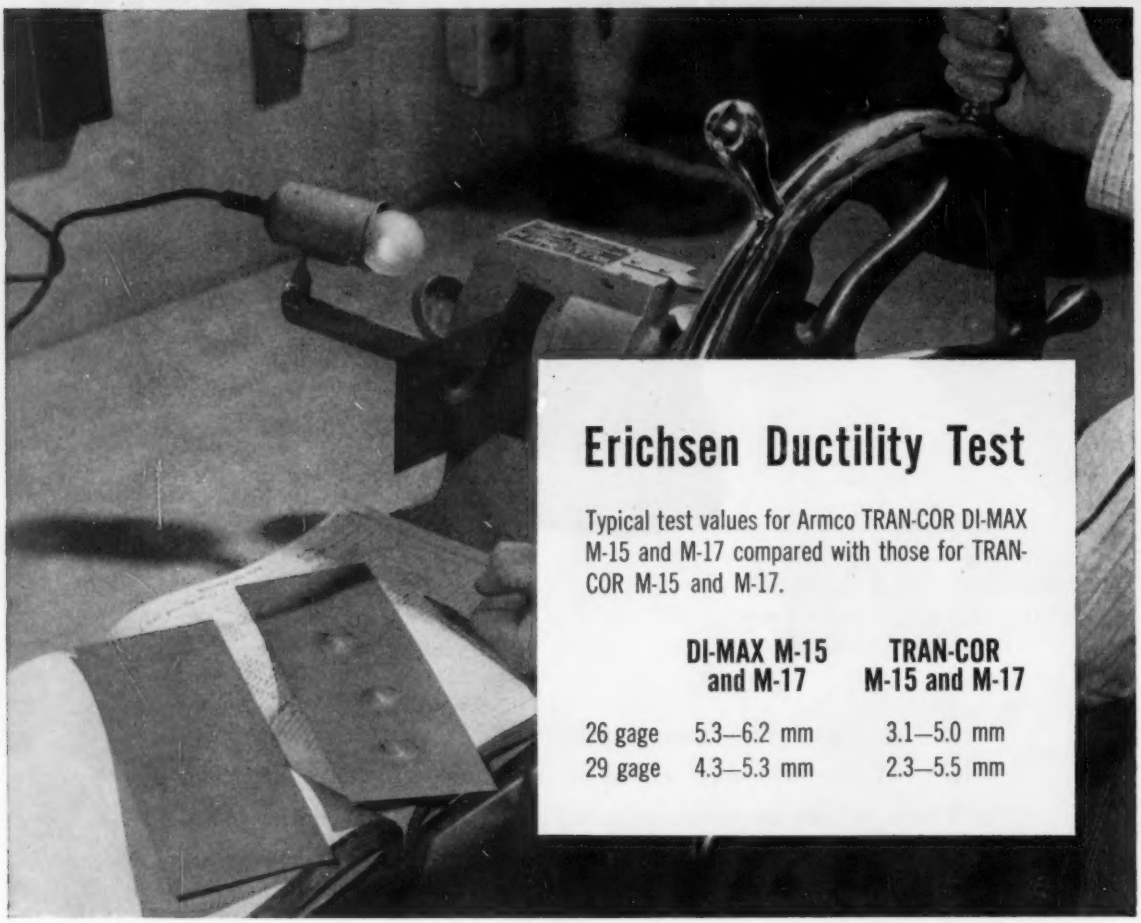
Aircraft-Marine Products, Inc.

A-MP

General Office: Harrisburg, Pa.

A-MP of Canada, Ltd., Toronto, Canada
A-MP—Holland N.V., 's-Hertogenbosch, Holland
Aircraft-Marine Products (G.B.) Ltd., London, England
Societe A-MP de France, Courbevoie, Seine, France

Armco DI-MAX Adds New Design "PUNCH" to M-15 and M-17 Grades



Erichsen Ductility Test

Typical test values for Armco TRAN-COR DI-MAX M-15 and M-17 compared with those for TRAN-COR M-15 and M-17.

	DI-MAX M-15 and M-17	TRAN-COR M-15 and M-17
26 gage	5.3—6.2 mm	3.1—5.0 mm
29 gage	4.3—5.3 mm	2.3—5.5 mm

Armco's DI-MAX process now offers a new design advantage in the low core loss M-15 and M-17 electrical steels. Better, more uniform ductility now makes it possible for designers to use punched laminations where they need the low core losses of these grades.

Besides punchability, Armco TRAN-COR DI-MAX M-15 and M-17 offer other performance-improving properties. In large motors and generators, induction regulators, TV power transformers and other applications calling for segmented, "E" and "I" or rectangular laminations, here are some of the plus factors you get:

- **Better permeability at high inductions**
- **Greater gage uniformity**
- **Better space factor**
- **Smoother surface**
- **Improved flatness**

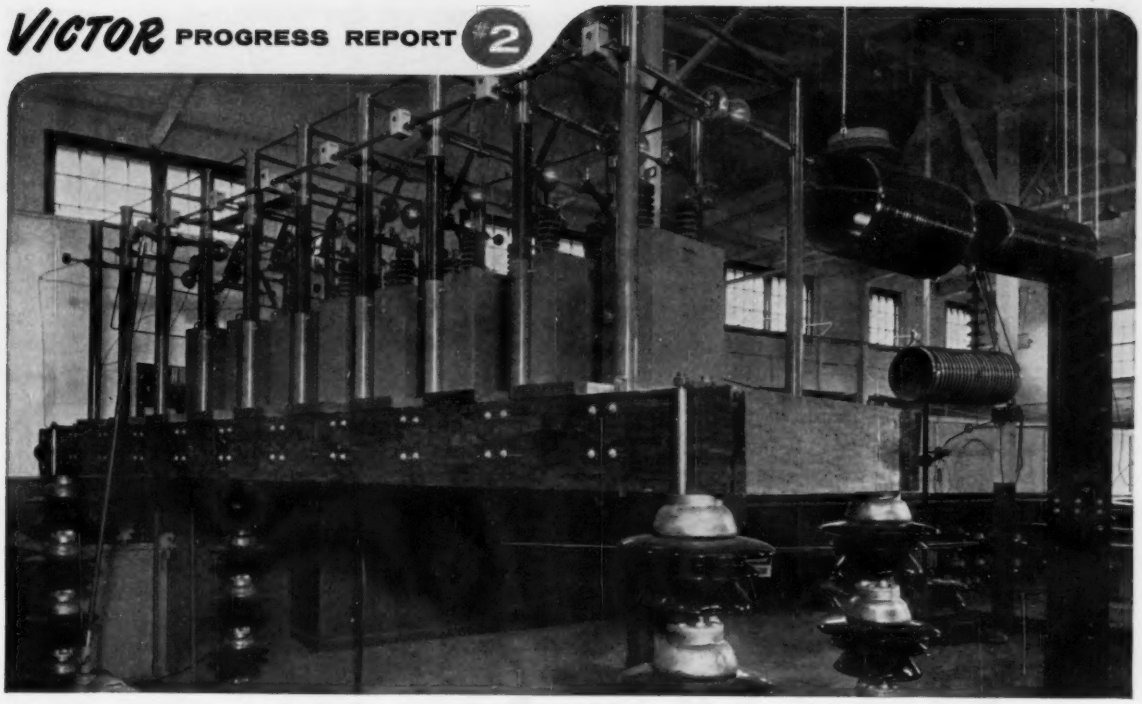
For complete information on how DI-MAX M-15 and M-17 can help you design and produce more efficient electrical equipment, write us at the address below or phone the nearest Armco Sales Office.

ARMCO STEEL CORPORATION

1146 CURTIS STREET, MIDDLETOWN, OHIO

SHEFFIELD STEEL DIVISION • ARMCO DRAINAGE & METAL PRODUCTS, INC. • THE ARMCO INTERNATIONAL CORPORATION

VICTOR PROGRESS REPORT #2



We make our own LIGHTNING to give you INSULATORS that last

Shown above is VICTOR'S 800,000-volt impulse generator in our modern electrical laboratory. This unit, together with VICTOR'S complete mechanical and electrical test facilities, enables our engineers to simulate the most extreme service conditions.

Included in this unit are a remote controlled gap spacing mechanism, an oscillograph for showing wave forms visibly on the screen of a cathode ray tube and a 4″ x 5″ camera for recording these waves on film for observation and study.

One more reason why VICTOR gives you insulators that last—that are design-tested to withstand lightning and other adverse service conditions. VICTOR'S modern plant, engineering and research facilities are unsurpassed in the field. You just can't buy better insulators!

"BETTER INSULATORS THROUGH RESEARCH"

• SPECIFY *VICTOR*
Purified Porcelain Insulators!

VICTOR INSULATORS DIVISION
I-T-E CIRCUIT BREAKER CO.
VICTOR, N. Y.

Low and High Voltage Pintypes • Suspensions • Guy Strains
Spools • Switch and Bus Insulators • Custom Designed Porcelain
Insulator Hardware

1
2
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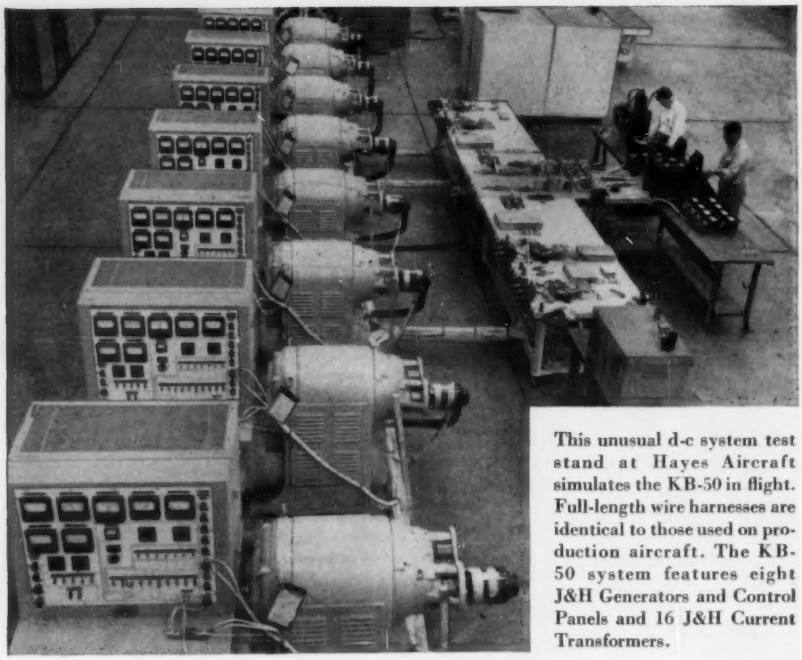
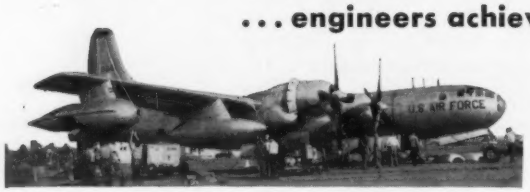


This unusual d-c system test stand at Hayes Aircraft simulates the KB-50 in flight. Full-length wire harnesses are identical to those used on production aircraft. The KB-50 system features eight J&H Generators and Control Panels and 16 J&H Current Transformers.

8 Jack & Heintz Generators paralleled in unique d-c system!

. . . engineers achieve 78% more power for KB-50



The KB-50 will have tremendous refueling capacity. Plans call for fueling of three planes simultaneously.

In converting the Boeing B-50 Superfort into the KB-50 mid-air refueling tanker, a substantial power boost was needed to drive the array of rapid-transfer fuel pumps honeycombed throughout the plane.

The approach lay in developing a new higher rated generator or in paralleling eight available 400-amp machines.

The Jack & Heintz G23 d-c Generator proved to be the answer. Rugged enough to withstand the high vibration characteristics in the KB-50, this generator required only a specially machined housing and a modified mounting flange.

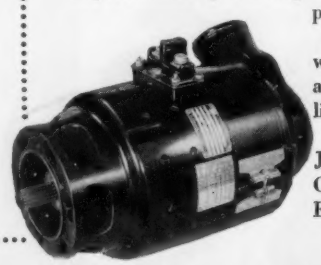
Through the use of the G23, Hayes and Jack & Heintz engineers have achieved a power supply of 3200 amps in the same available space once yielding a maximum of 1800 amps. The unprecedented paralleling of eight generators has been test-proved completely reliable.

Also available is a modified G23 with an increased rating of 450 amps, which is ideally suited to airline applications.

For complete information, write Jack & Heintz, Inc., 17622 Broadway, Cleveland 1, Ohio. Export Dept.: 13 E. 40th St., New York 16, N. Y.

Jack & Heintz G23 Generator

Rating—amp	400
Voltage—d-c	30
Speed Range—thousand rpm	3.8-8
Weight—lb	67
Dimensions—inches	
Over-all Length (from mounting flange)	13 31/32
Over-all Diameter	8
Bolt Circle Diameter	5
Spline, Pitch Diam	.8
Air Inlet Conn., OD	3
Cfm of Air at 6" H_2O & 6000 rpm	165
Rotation as Viewed from end Opposite Flange	CW



©1956 by Jack & Heintz, Inc.

JACK & HEINTZ *Rotomotive* **AIRCRAFT EQUIPMENT**

WRITE for the complete story of BRONCO 66 CERTIFIED, the dependable, extra flexible, electrical cables through which energy flows to the power tools of industry. These Synchro-Cured portable electrical cords and cables are made with a branded jacket certified to contain not less than 67.32% Neoprene.

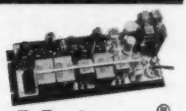
Send for free brochure to:

WESTERN INSULATED WIRE CO., Los Angeles 58, California

ASK YOUR ELECTRICAL WHOLESALE DISTRIBUTOR FOR THE CABLE WITH THE 66% NEOPRENE JACKET

VOICE COMMUNICATION *PLUS* Control

RFL Model 983 OPERATES OVER WIRE CIRCUIT OR MICROWAVE



Voicon®

VOICE plus CONTROL Terminal

- 2-Way Clear Voice and Reliable Control
- Frequency-Shift Fail-Safe Operation

Provides two, reliable frequency shift control channels at 2800 & 3000 cps isolated from voice by filters. Isolation transformers allow connection to balanced wire circuits. Interchangeable plug-in components and printed circuit boards are used in transmitter, receiver and power supply sections.

The VOICON is one of many RFL terminal units for control, telemetering, teletype, voice or data transmission.

Write for Technical and Application Data.

Radio Frequency LABORATORIES, INC.
Boonton, New Jersey, U. S. A.

Industrial Notes

(*Continued from page 26A*)

The instrument makes it possible to measure and count the particles at the rate of 12,000 per minute and is capable of measuring microscopic airborne particles such as germs, dust, smog, moisture, and pollen. Particles ranging in size from 1 micron (40 millionths of an inch) to 64 microns are counted and measured by the instrument.

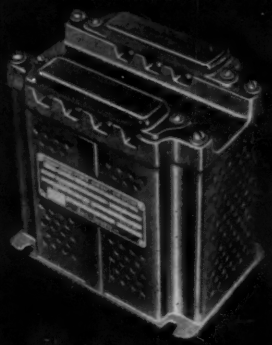
Computing Center To Be Installed. The Franklin Institute has signed a contract with Remington Rand Univac Division of Sperry Rand Corporation for the installation of a complete Univac computing center, and integrated computation exhibit. The computing center will be operated by institute personnel under the supervision of Donald Houghton, chief of the Analysis Section, Division of Electrical Engineering, The Franklin Institute Laboratories. The facilities of the center will be used both for the laboratories, and for business and commercial problems. Development of improved computing procedures will be studied at the new center by both Remington Rand and Franklin Institute. The exhibit area will graphically portray the historical evolution of the art of computation from the abacus to the modern electronic computer. Trained guides will explain to the Institute's 300,000 annual visitors the operation of these mechanical "brains" so that the complexities of these ultramodern devices will be easily understandable to students and lay adults.

NEW PRODUCTS

Pulse Transformers Have Toroidal Windings. A new series of pulse transformers, developed by the Acme Electric Corporation of Cuba, N. Y., makes use of a solid ferrite core in a toroidal winding. Connections are made to a 9-pin base and the entire unit is hermetically sealed in molded epoxy resin. These units are designed for blocking oscillator circuits and

(*Continued on page 36A*)

NEW A-C POWER TRANSFORMER



First of J&H line... betters Spec MIL-T-9219

Now in use on such leading aircraft as the Boeing B-47 and Consolidated Diesel Electric's and Beech's MD-3 ground power units, the Jack & Heintz GC150 wye-to-delta power transformer has passed all qualification tests.

Designed to MIL-T-9219, the transformer offers a higher guaranteed efficiency and closer regulation than required by the specification.

ENGINEERING DATA

Rating	1.5 kva at 0.8 pf
Frequency	380-440 cps
Primary Voltage	200 volts L-L
Secondary Voltage	115 volts L-L
Guaranteed Efficiency (25°C ambient)	93%
Regulation at Rated Load	4%
Five-Minute Rating	2.25 kva at 0.8 pf
One-Minute Rating	3.75 kva at 0.8 pf
Ambient Temperature	-65°C to +71°C
Altitude	50,000 ft (0°C)
Weight	6.5 lb

For complete design details or for information concerning the availability of power transformers in other ratings, write Jack & Heintz, Inc., 17622 Broadway, Cleveland 1, Ohio. Export Dept., 13 E. 40th St., New York 16, N. Y.

©1956 by Jack & Heintz, Inc.

JACK & HEINTZ Rotomotive AIRCRAFT EQUIPMENT

RADIO INTERFERENCE AND FIELD INTENSITY *measuring equipment*

Stoddart equipments are suitable for making interference measurements to one or more of the following specifications:

AIR FORCE—MIL-I-6181B
150 kc to 1000 mc
BuAir—MIL-I-6181B
150 kc to 1000 mc
BuShips—MIL-I-16910A (Ships)
14 kc to 1000 mc
SIGNAL CORPS—MIL-I-11683A
150 kc to 1000 mc
SIGNAL CORPS—MIL-S-10379A
150 kc to 1000 mc

The equipments shown cover the frequency range of 14 kilocycles to 1000 megacycles.

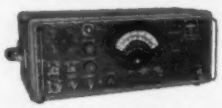
Measurements may be made with peak, quasi-peak and average (field intensity) detector functions.

F.C.C. PART 15—Now in effect, the revised F.C.C. Part 15 places stringent requirements upon radiation from incidental and restricted radiation devices. Stoddart equipment is suitable for measuring the radiation from any device capable of generating interference or c-w signal within the frequency range of 14 kc to 1000 mc.

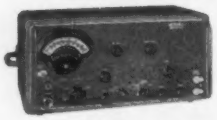
Write Stoddart Aircraft Radio Co., Inc., for your free copy of the new revised F.C.C. Part 15.

NM-10A (AN/URM-6B)
14 kcs to 250 kcs

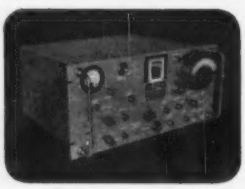
NM-20B (AN/PRM-1A)
150 kcs to 25 mcs



NM-30A (AN/URM-47)
20 mcs to 400 mcs



NM-50A (AN/URM-17)
375 mcs to 1000 mcs



The **Stoddart NM-40A** is an entirely new radio interference-field intensity measuring equipment. It is the commercial equivalent of the Navy type AN/URM-41 and is tunable over the audio and radio frequency range of **30 CPS to 15 kc.** It performs vital functions never before available in a tunable equipment covering this frequency range. Electric and magnetic fields may be measured independently over this range using newly developed pick-up devices. Measurements can be made with a 3 db bandwidth variable from 10 CPS to 60 CPS and with a 15 kc wide broadband characteristic.

STODDART *Aircraft Radio Co., Inc.*
6644-B SANTA MONICA BLVD., HOLLYWOOD 38, CALIFORNIA · Hollywood 4-9294

New Products

(Continued from page 35A)

coupling circuits, and are applicable wherever a 9-pin socket can be located. Their small size and light weight make them adaptable for many types of electronic circuits such as are used in computers, and guided missiles; as well as many more common applications.

Mobile Transistorized Mike. Motorola has announced a transistorized dynamic microphone for mobile radio applications that provides mobile transmission quality comparable to that of a base station. The microphone features a rugged dynamic element employed in con-

junction with a built-in transistor preamplifier. Unexcelled voice intelligibility from the mobile unit is readily demonstrable. The transistor preamplifier, an integral part of the microphone, boosts the dynamic output to conventional transmitter input level, eliminating the need for a preamplification at the transmitter. This technique overcomes the noise pickup problem inherent in mobile installations. The amplifier draws its power from the conventional "talking current" supply. Additional information is available from Motorola Communications and Electronics, Inc., 4501 West Augusta Boulevard, Chicago, Ill.

Two New Beam Power Tubes. Announcement of two new beam power tubes, RCA-*6CU5* and RCA-*12CU5*, intended for use in the audio output stage of television receivers has been made by the Radio Corporation of America (RCA), Tube Division. The tubes, which are of the seven-pin miniature type, are similar, except that the *12CU5* has a 12.0-volt/0.6-ampere heater having controlled heating time to insure dependable performance in television receivers employing series-heater string arrangement. Because high-power sensitivity and high efficiency at low plate and screen voltages, the *6CU5* and *12CU5* are capable of providing a relatively high power output. In class *A1* amplifier service, for example, either tube when operated with a plate voltage of 120 volts and a grid number *2* voltage of 110 volts,

(Continued on page 40A)

Why NATIONAL *brushes are best for Electric Utility and Sub-Station Equipment*

"National" brushes offer a complete line of proved grades to meet every condition of operation – standard or special – all through the mill and mine. Here, for example, are the grades recommended for electric utility and sub-station equipment – with the services of a National Carbon brush specialist always available to help you in the final selection for each unit.

PRIMARY POWER TURBINES

Grade 634 **Grade R-64**

Universally recognized leaders in AC field excitation equipment.

Grade SA–45 **Grade SA-4542** **Grade N-4**

Grade SA-45 for most standard DC excitation equipment. Other grades may be required to meet special operating conditions.

SUB-STATION ROTARIES

Grade SA-45 **Grade 259** **Grade SA-35**

Standard grades, choice being determined by machine characteristics.

Grade 3538 **Grade N-4**

For unusual service – light loads or severe load swings.

AC SIDE OF ROTARY EQUIPMENT

Cophite grade 29 **Cophite grade 39**

Metal-graphite slip-ring formulation, applied according to current density.

EXCITER AND GENERAL PURPOSE DC EQUIPMENT

Grade 255 **Grade 259** **Grade SA-35**

Standard choices, based on service requirement.

Grade 258

Special for low current density applications.

WITH VALUABLE EQUIPMENT, IT PAYS TO BE SURE – CONSULT A "NATIONAL" CARBON BRUSH SPECIALIST!

The term "National", the Three Pyramids Device and the Silver Colored Cable Strand are registered trade-marks of Union Carbide and Carbon Corporation

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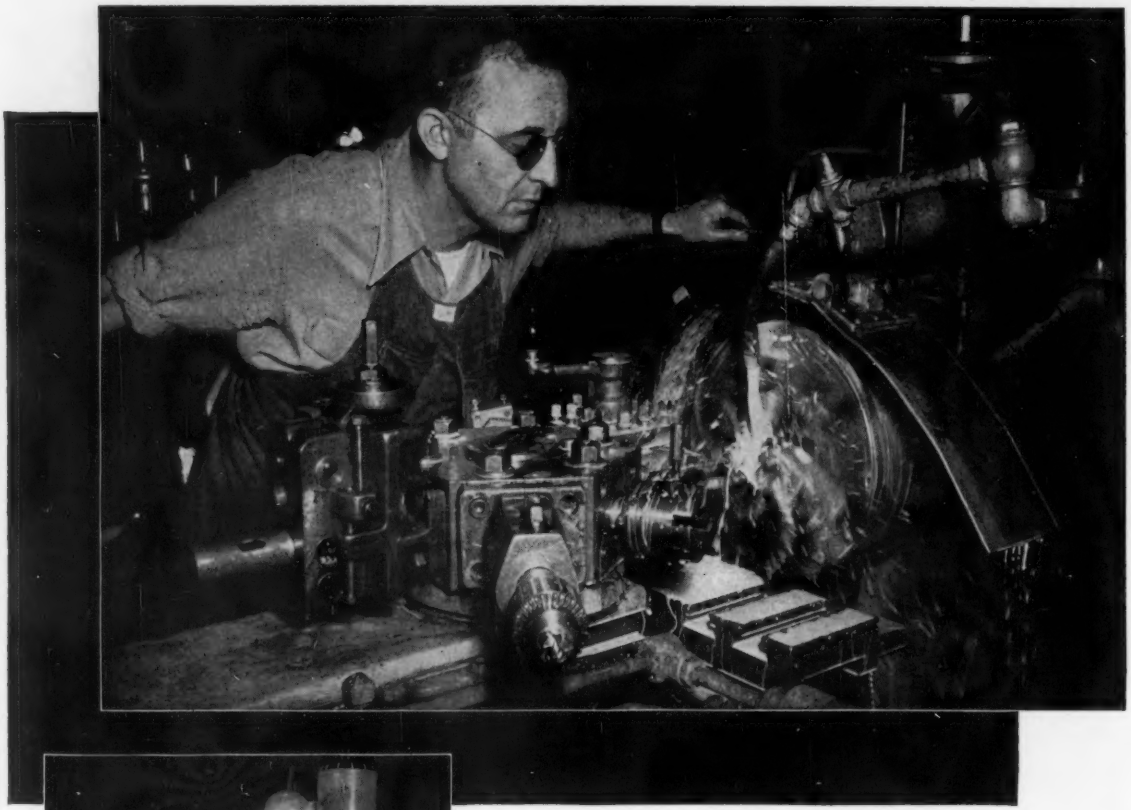
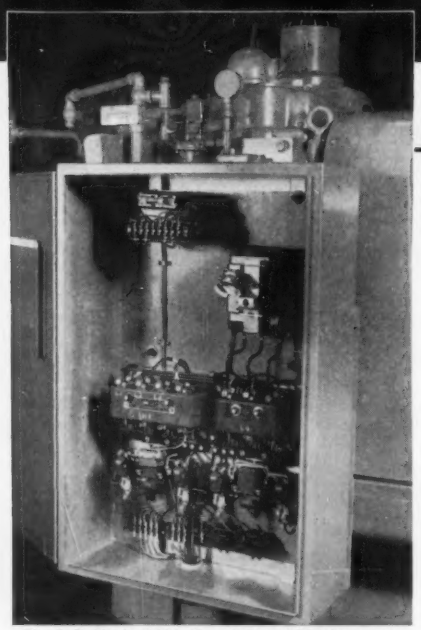




Clark Bulletin 6050, Size 2 Type "CY" Starter for Single Winding 2 Speed Constant Torque A.C. Motor used on Warner & Swasey Universal Turret Lathes.

→ CLARK CONTROLS help Warner & Swasey lathes

"machine better, faster, for less"

● Selected for long, trouble-free performance, Clark Bulletin 6050 Size 2, Type "CY" 2-speed starters are used on Warner & Swasey's No. 5 Universal Turret Lathes. Maintenance and wear on contact tips are reduced to a minimum as a result of an exclusive arc quenching method employed on Type "CY" starters. Effective arc interruption and reduced wear on tips is accomplished by using strong multi-turn magnetic blowouts and double-break contacts. Forced rotation continuously moves the arc from a hot to a cold spot, distributing the heat evenly over entire contact, preventing pitting or "build-up." Tips require no cleaning or dressing over long years of maintenance-free operation.

Write for complete descriptive literature.

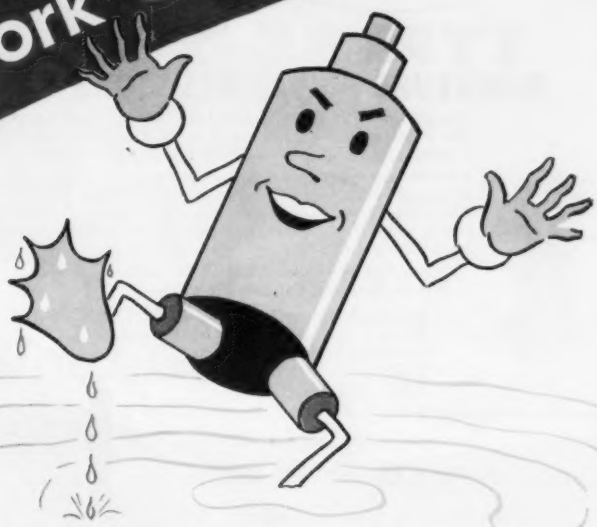
The **CLARK** **CONTROLLER** *Company*

Engineered Electrical Control

1146 East 152nd Street • • Cleveland 10, Ohio

IN CANADA...CANADIAN CONTROLLERS, LIMITED • MAIN OFFICES AND PLANT, TORONTO

How to put "WEBBED FEET" on Network Cables



Water entering ducts floods low voltage network circuits as quickly as it engulfs high voltage primaries.

That's one reason why Simplex Network Cables are insulated with Anhydrex. It's also an excellent reason for you to buy them.

Anhydrex is guaranteed to absorb no more than 20 milligrams of water when soaked for seven days at 158°F.

You can keep your amperes dry as a bone by getting Anhydrex-insulated, neoprene-jacketed, Simplex-ANHYDREX Network Cable. Use it for direct burial, in ducts, or above ground suspended from messenger wire.

For more information about Simplex Network Cables, write to the address below. Ask your nearest Simplex distributor about his complete line of ANHYDREX Cables.

Simplex–ANHYDREX

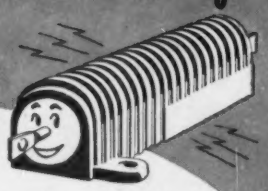
NETWORK CABLES

SIMPLEX WIRE & CABLE CO., 79 Sidney Street, Cambridge 39, Mass.

I'm DALOHM... miniature but mighty!

You can depend on

DALOHM Ω



TYPE RH

MINIATURE POWER RESISTORS

For all applications where the equipment must survive the most severe environmental, shock, vibration, humidity and temperature conditions.

Smallest in size; completely welded from terminal to terminal; silicone sealed in a die-cast black anodized aluminum housing and mounts on sub-panel for maximum heat dissipation; impervious to moisture, salt ions, vapor and gases.

Three wattage ranges: RH-25, 25 watts; RH-50, 50 watts; RH-250, 250 watts.

- Temperature coefficient 0.00002/Deg. C
- Ranges from 0.1 ohm to 55,000 ohms, depending on type
- Tolerances 0.05%, 0.1%, 0.25%, 0.5%, 1%, 3%, 5%

Conform to applicable JAN and MIL Specifications

Write for Bulletin R-21-B

DALE PRODUCTS, INC.

Phone 2139

1312 28th Ave. Columbus, Nebraska, U.S.A.

Export Dept.: Pan-Mar Corp., 1270 Broadway, New York 1, N.Y.

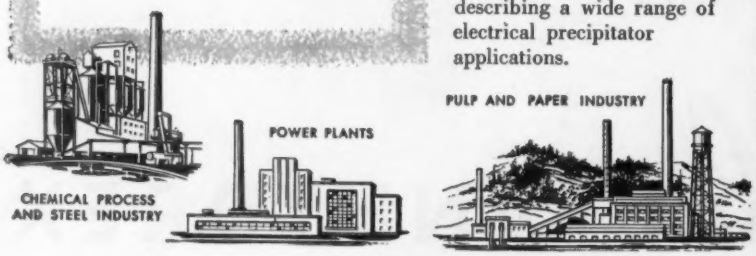
In Canada: Charles W. Pointon, Ltd., 6 Alcina Ave., Toronto

Industry looks to

RESEARCH -COTTRELL

for high dust collection efficiencies

To maintain visually clean stacks at all times, industry is turning to the long experience of Research-Cottrell in the design and manufacture of highly efficient Cottrell Electrical Precipitators. We've spent 40 years in solving such problems as nuisance abatement, cleaning gas for subsequent use and recovering materials of value. Write for illustrated bulletin describing a wide range of electrical precipitator applications.



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228 N. La Salle St., Chicago 1, Ill. • 111 Sutter St., San Francisco 4, Cal.

New Products

(*Continued from page 36A*)

can deliver a maximum signal power output of 2.3 watts.

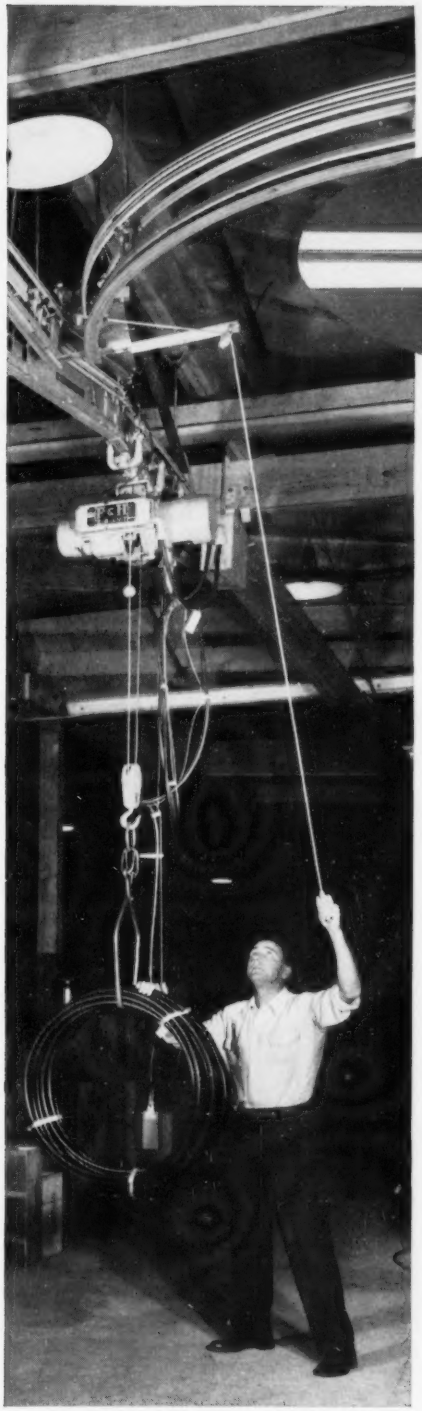
Toggle Switch Has Ability to "Remember." A new toggle switch with an "electrical memory" has been developed by Micro Switch of Freeport, Ill., a division of Minneapolis-Honeywell Regulator Company. The unit, first of a new series, is a 4-pole assembly with 1 pole for indicating which circuit was last operated. The new switch promises to simplify and possibly revolutionize some basic circuit designs of complicated ground radar units, computer devices, aircraft control panels and other types of remote control equipment. The switch assembly, designated *21AT1*, uses 3 single-pole double-throw functional basic switches and one single-pole double-throw "memory" switch. In application, the memory switch indicates through a pilot light or buzzer which circuit was last actuated. The three functional switches operate at three lever positions; maintained center and momentary from each extreme position. Two of the switches are actuated when the lever is moved to one extreme position and the other switch is actuated in the other extreme position. The basic switch, which is used for the "electrical memory," is actuated in one extreme lever position and is released in the other extreme position. The lever returning to the center position does not affect the memory switch, which indicates the extreme position which the lever is in or was in most recently.

New Headset. A new concept in headset design results in better perception of oral sound according to Telex, Inc., St. Paul, Minn. The new headset, called Duodyne, was developed from data supplied by a United States Army research project conducted at the University of Cincinnati. The project revealed that a few milliseconds in time delay in reception in one ear contributed to better understanding of speech.

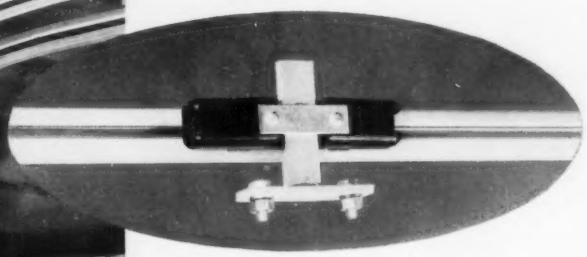
(*Continued on page 46A*)

Another new development using

B. F. Goodrich Chemical *raw materials*



B. F. Goodrich Chemical Company does not manufacture this extrusion. We supply only the Geon rigid vinyl materials.

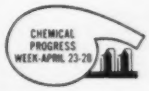


Rigid Geon packs power in small space

NAKED wires on an overhead power lift are a hazard, lose power along the line and have to be spaced widely where multiple electrical contacts are needed in large plants. As a product improvement, a manufacturer has designed U-shaped extruded insulation made of Geon rigid vinyl that has many advantages for the job.

The rigid vinyl extrusion carries a metal contact conductor safely so that as many as three to twelve power lines can be installed close together where space is tight. Because this insulation is made of Geon rigid vinyl it has high dielectric strength, high insulation resistance with low power loss. It has good chemical and abrasion resistance, necessary for long life in industrial plants and it can be colored according to local code requirements.

This installation you see here is a good example of a new use for Geon rigid vinyl. It may suggest a new use to you or may give you an idea for another saleable product. There are scores of other uses for Geon materials from rigid sheeting to rigid pipe and fittings. For technical help in the uses of versatile Geon please write Dept. DH-2, B. F. Goodrich Chemical Company, Rose Building, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.



GEON RESINS • GOOD-RITE PLASTICIZERS . . . the ideal team to make products easier, better and more saleable.
GEON polyvinyl materials • HYCAR American rubber and latex • GOOD-RITE chemicals and plasticizers • HARMON colors

GENERAL ELECTRIC ANNOUNCES . . .
NEW Industrial
GENERAL ELECTRIC
DIRECT CURRENT MOTOR
RPM
VOLTS
AMPS
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Direct-current Motor

KINAMATIC* a new standard in direct-current motors, gives your machines wider speed ranges, greater output

To meet modern industrial needs for faster, more automatic, more continuous production, General Electric has designed an entirely new direct-current motor—the d-c Kinamatic.

Designed for Automation—Now, a direct-current motor has been designed for the modern job it has to do—either as individual motor drive or in regulating systems. The new General Electric d-c Kinamatic motor supplies the wide speed range and versatility required for today's manufacturing methods. It is designed for the close control of machines and split-second timing of processes essential to higher output.

Accelerated Production—The new d-c Kinamatic motor will modernize your equipment, give it increased power, higher speeds, greater output capacity. With the quick-acting G-E Kinamatic motor, your machines will process a greater variety of products . . . faster . . . easier . . . and with less maintenance and spoilage.

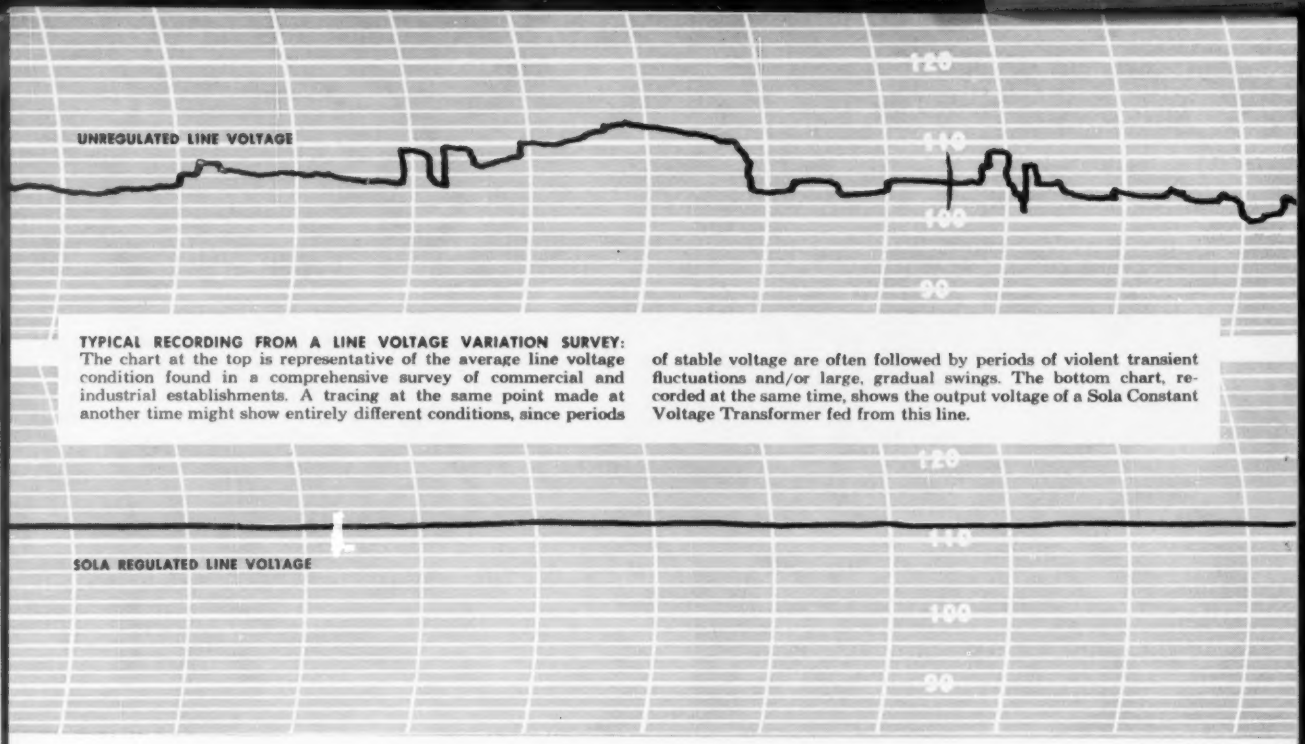
More Powerful—By combining advanced design with improved materials and manufacturing techniques, General Electric engineers have packed more power into the entire Kinamatic line. The powerful Kinamatic motor, with new stamina and durability, is ready to become one of your most effective weapons for keeping costs down, for meeting competition, for boosting productivity levels.

Engineering Help—Industrial specialists in 149 conveniently located General Electric Apparatus Sales Offices have the complete story on how the new d-c Kinamatic motors and generators can benefit your operation. For full details, contact your G-E Sales Representative, or write for Bulletin GEA-6355. *Direct Current Motor and Generator Department, General Electric Company, Erie, Pennsylvania.* 813-1

* Trade Mark of the General Electric Company

Progress Is Our Most Important Product

GENERAL ELECTRIC



TYPICAL RECORDING FROM A LINE VOLTAGE VARIATION SURVEY: The chart at the top is representative of the average line voltage condition found in a comprehensive survey of commercial and industrial establishments. A tracing at the same point made at another time might show entirely different conditions, since periods of stable voltage are often followed by periods of violent transient fluctuations and/or large, gradual swings. The bottom chart, recorded at the same time, shows the output voltage of a Sola Constant Voltage Transformer fed from this line.

End Fluctuating Line Voltage Handicap to Reliable Product Performance

Where line voltage fluctuations impair the performance of voltage-sensitive electronic equipment, Sola Constant Voltage Power Transformers often provide a simple, economical solution. Stock or custom designed units are available.

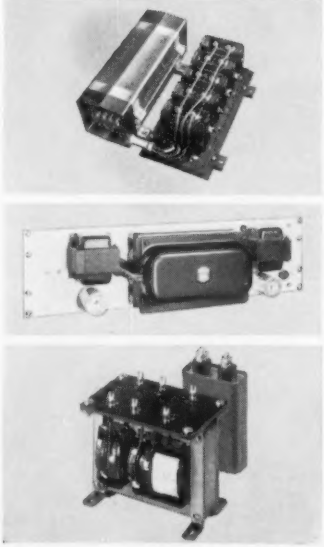
The Sola regulator has no moving parts and requires no manual adjustment or maintenance. Operation is automatic with response time 1.5 cycles or less. Regulates as close as ±1% with line voltage variations as great as 30%.

To meet special load requirements or service conditions, units can be custom-designed for production quantity orders. Variations available for special-order work include:

- *Capacity ranges from a fraction of a va to 30kva*
- *Wide variety of voltage inputs and outputs*
- *Frequencies other than 60 cycles*
- *Provisions for wide ambient temperature ranges*
- *Structural features for installation as a component*
- *Premium mechanical features for military service and other special duty*

The cost of Sola voltage regulation may be far less than you anticipate for two reasons: 1) installation of a Sola unit eliminates the need for the conventional non-regulating power supply transformer and any regulating components which you may currently use . . . 2) your requirements may be satisfied by a stock unit or custom design already on file. A Sola sales engineer is always available to discuss your voltage regulation requirements with you.

TYPICAL CUSTOM-DESIGNED SOLA POWER TRANSFORMERS



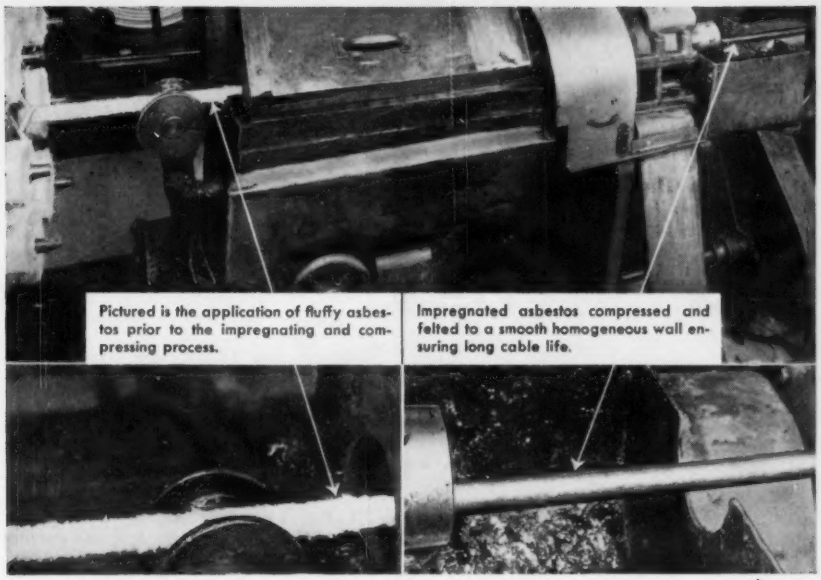
SOLA *Constant Voltage* **TRANSFORMERS**

Write for Bulletin 5 D-CVES for facts on the complete line of Sola Constant Voltage Power Transformers.

CONSTANT VOLTAGE TRANSFORMERS for Regulation of Electronic and Electrical Equipment • **LIGHTING TRANSFORMERS** for All Types of Fluorescent and Mercury Vapor Lamps. • **SOLA ELECTRIC CO., 4633 West 16th Street, Chicago 50, Illinois, Bishop 2-1414** • *BOSTON:* 272 Centre Street, Newton 58, Massachusetts • *NEW YORK 35:* 103 East 125th Street • *LOS ANGELES 26:* 2025 Sunset Boulevard • *PHILADELPHIA:* Commercial Trust Building • *CLEVELAND 15:* 1836 Euclid Avenue • *KANSAS CITY 2, MISSOURI:* 406 West 34th Street • *TORONTO 9, ONTARIO:* 617 Runnymede Road

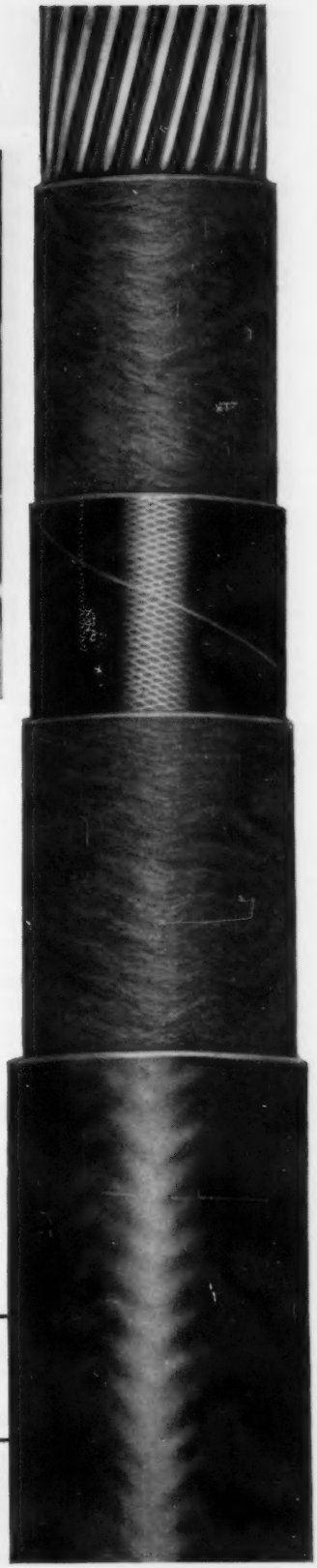
Representatives in Other Principal Cities

seamless FELTED ASBESTOS walls add up to long range economical service



Pictured is the application of fluffy asbestos prior to the impregnating and compressing process.

Impregnated asbestos compressed and felted to a smooth homogeneous wall ensuring long cable life.



look beneath the braid

. . . that's where quality begins

Long lasting, trouble-free circuit performance depends on the materials and construction of wire and cables. And a look under the braid shows why Rockbestos A.V.C. (N.E.C. Type AVA) is built to give longer service.

The two seamless, dense felted asbestos walls, compressed and thoroughly impregnated with selected compounds, seal the varnished cambric from heat and moisture.

Dielectric strength stays high under high ambient temperatures. Heat dissipation is uniform. The felted wall construction protects the varnished cambric from rupture in the sharpest bends.

HERE'S HOW YOU BENEFIT*

Get high dielectric values from Varnished Cambric because of its controlled application over seamless felted asbestos walls.

HIGH DIELECTRIC STRENGTH — minimum breakdown voltages for 600 and 1000 volt power cables — 15 KV.

MOISTURE RESISTANCE — same minimum dielectric breakdown — wet or dry — 15 KV on 600 and 1000 volt power cables.

RUGGED CONSTRUCTION — minimum breakdowns after bending tests — 15 KV for 600 and 1000 volt power cables all sizes.

CONTROLLED QUALITY — materials and workmanship and performance under rigid Quality Control.

CUTS MAINTENANCE COSTS — It won't bake brittle, crack or flow in high ambients . . . won't deteriorate with age, or rot when exposed to oil, grease or fumes.

The result: wire failures are eliminated; maintenance costs are held down; plant and equipment operation maintained at top level.

*Write for the test and construction specifications of Rockbestos A.V.C. (N.E.C. Type AVA) available in the new booklet, "Specification RSS-88."

STOCKED COAST TO COAST
Standard Rockbestos A.V.C. construction (N.E.C. types AVA, AVB, etc.) are available for immediate shipment. Call or write nearest branch office.

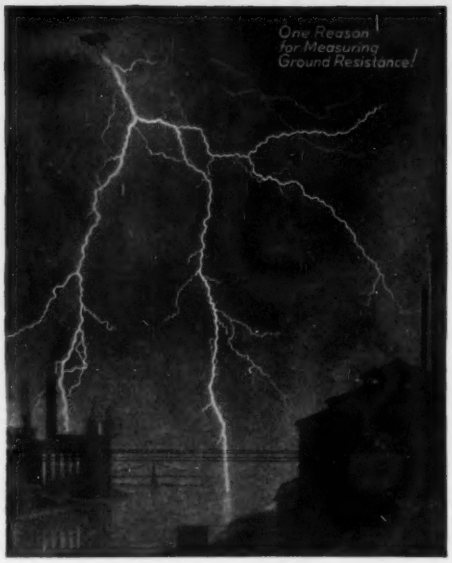
ROCKBESTOS PRODUCTS CORP.
NEW HAVEN 4, CONNECTICUT

NEW YORK CLEVELAND • DETROIT • CHICAGO • PITTSBURGH • ST. LOUIS • LOS ANGELES • NEW ORLEANS
OAKLAND, CALIFORNIA

BIDDLE *Instrument News*

IT TAKES ONLY ONE STRIKE

. . . to knock out important electrical equipment



The season for electrical storms will soon be with us again in many sections of the country. The insidious thing about lightning is that it strikes at your plant's power system. Nine-tenths of the industrial damage it causes is to vital electrical equipment—motors, generators, transformers—or to power house chimneys. But this damage is of small consequence compared to the loss of power and stoppage of production. To prevent such losses, ground connections on lightning rods and arresters must be kept in good condition.

Test Grounds Once a Year

Properly installed and grounded lightning arresters are the first line of defense in protecting important electrical equipment such as generators, switchboards and transformers from lightning damage. Similarly, factory stacks are less subject to damage if protected by lightning rods and conductors that permit the stroke to pass harmlessly to earth.

In spite of apparently good lightning rod or arrester protection, lightning frequently will cause severe damage if high ground resistance hampers its dissipation in the earth.

Experience has shown that ground resistance does not remain constant and that tests should be made at least once a year, and high ground resistance corrected.

"Megger" Method

This is the simplest, easiest, quickest and most accurate method of determining ground resistance, and should be used wherever possible. The "Megger"® Ground Tester is an instrument specially designed for this purpose.

By virtue of the Megger crossed-coil ohmmeter the Megger Ground Testers are *direct-reading* in ohms. The operator reads the resistance value from the deflection of a pointer over a scale, as simply and easily as reading a voltmeter. These results are secured with only *one set of connections*, in *one operation*, and *without any calculations*.

For measurements of ordinary ground resistance, two auxiliary or reference grounds are required; or, connection may be made to a water system or other metallic structure that is known or assumed to have zero resistance to earth. The ohmmeter then indicates the resistance to earth of the ground under test.

Resistance of Grounds Should Not Exceed 5 Ohms

If tests show the resistance to ground is over 5 ohms, the resistance should be reduced by connecting to underground water pipes, copper plates or driven rods.

Want Help on Grounding Problems?

Write for these bulletins:

Bulletin 25-J-EE — A Manual on Ground Resistance Testing
Bulletin 25T2EE—"Grounding Electric Circuits Effectively"
Bulletin 25T4EE—"Grounding Principles and Practices as Applied to Industrial Plants"

B-604

JAMES G. BIDDLE CO.

- ELECTRICAL TESTING INSTRUMENTS
- SPEED MEASURING INSTRUMENTS
- LABORATORY & SCIENTIFIC EQUIPMENT

1316 ARCH STREET
PHILADELPHIA 7, PA.

New Products

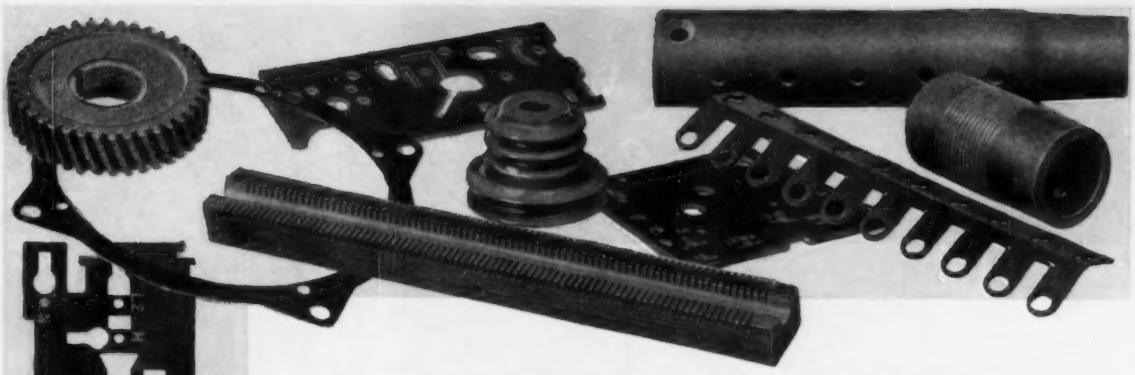
(*Continued from page 40A*)

The headset creates the audio effect presence at the source of the sound—voice or music. Telex produces the "live" effect by inducing a 5 millisecond time delay in transmitting sound to one ear piece. One dynamic driver is located in a Tenite housing with the *PL-55* plug and is separated from the second driver in the tone arm junction by 5 feet of plastic tubing. Each driver feeds a separate ear; one driver emphasizes highs, the other, lows. Weighing 2 ounces, this under-the-chin style headset has a frequency response of from 100 to 8,000 cycles per second, and an impedance of 15 ohms. Comfortable listening level is attained with a 1-milliwatt power input. For additional details on the Duodyne headset, write Telex Inc., Telex Park, St. Paul, Minnesota.

Distribution Transformer Overload Indicator. A new overload indicator, type *TD*, for conventional distribution transformers that keeps a permanent and accurate record of overload hours based on copper temperatures is available from Westinghouse Electric Corporation. The new indicator aids in prediction of transformer life, gives advance warning for change-out scheduling, and is easy to read from the ground. The unit consists of three parts: a control thermostat that responds to copper temperature; a motor or timing mechanism that records the number of overload hours on a dial; and a signal light which serves as an auxiliary warning. The timing motor and the signal light are supplied by an auxiliary winding that is not exposed to surges. The thermostat actuates the timing mechanism whenever the thermal capability of the windings is exceeded. The timing motor continues to run as long as an overload is present and records on the dial the number of hours the transformer has operated above its thermal capability. The signal light also turns on, but remains on only as long as the overload persists. When the winding temperature drops, the timing motor shuts off, but the indicator does not reset. It continues to show a cumulative total of the number of overload hours. The bimetallic, hermetically-sealed thermostat is placed inside an insulated-cell. This cell is inserted into a metal tube which in turn is placed in close contact with a current-carrying conductor. The timing mechanism consists of a low-voltage hysteresis motor mounted integrally with a gear train that drives the pointer on the dial. The dial will record a total of 300 overload hours. For further information, write to Westinghouse Electric Corporation, Post Office Box 2099, Pittsburgh, Pa.

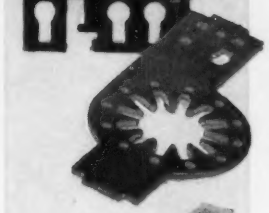
Rust Preventive. Valvoline Tectyl *506*, a rust and corrosion preventive, that was used to preserve the piping and fittings prior to installation in the United States Navy's two new nuclear submarines the *U.S.S. Nautilus* and *U.S.S. Seawolf*, was supplied by the Electric Boat Division of General Dynamics Corporation. One application of Valvoline Tectyl *506* gives rust-

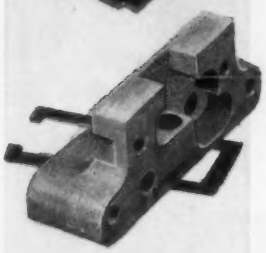
(*Continued on page 50A*)



ALL MACHINED TO EXACT CUSTOMER SPECIFICATIONS

ALL MADE BY Spaulding PRODUCTS





Smooth, clean results are possible in every application because Spaulding Products lend themselves easily to all forming, turning, drilling, threading, punching, shearing, sawing and swaging operations.

This affinity for exact machining, plus resistance to most chemicals, good dielectric qualities, extreme durability and great strength with light weight has made Spaulding Products a leader in the laminated plastic and fibre fields.

Always look to Spaulding when **your** needs call for a part with unique physical properties. One or a combination of Spaulding's many types and grade of basic material can fill them quickly, accurately and economically.

WE MAKE AND FABRICATE

VULCANIZED FIBRE: In sheets, rods, tubes and fabricated parts.

ARMITE: Thin Insulation (Fish Paper) in sheets, rolls, coils and fabricated parts.

SPAULDITE: (Laminated Thermosetting Plastic) in sheets, rods, tubes and fabricated parts.

SPAULDO: Motor Insulation in sheets, rolls, coil, slot cells and other fabricated parts.

SPAULDING FIBRE BOARD: In sheets and fabricated parts.

SPAULDING T BOARD: A superior Transformer Board in sheets and fabricated parts.

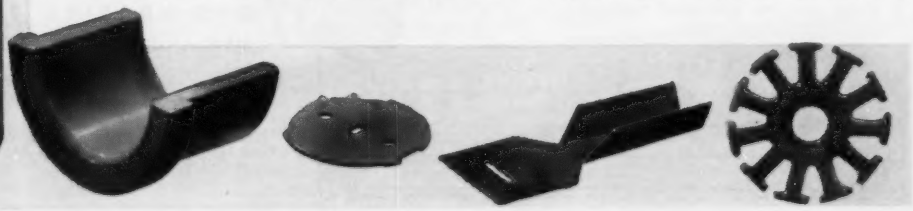
MATERIALS HANDLING EQUIPMENT: Factory Trucks, Boxes, Barrels, Trays, etc.

SPAULDING FABRICATING FACILITIES: Spaulding's fabricating facilities for these products are unsurpassed the world over. You can save time and money by letting us do your fabrication. We'll be glad to quote on specific jobs without obligation.

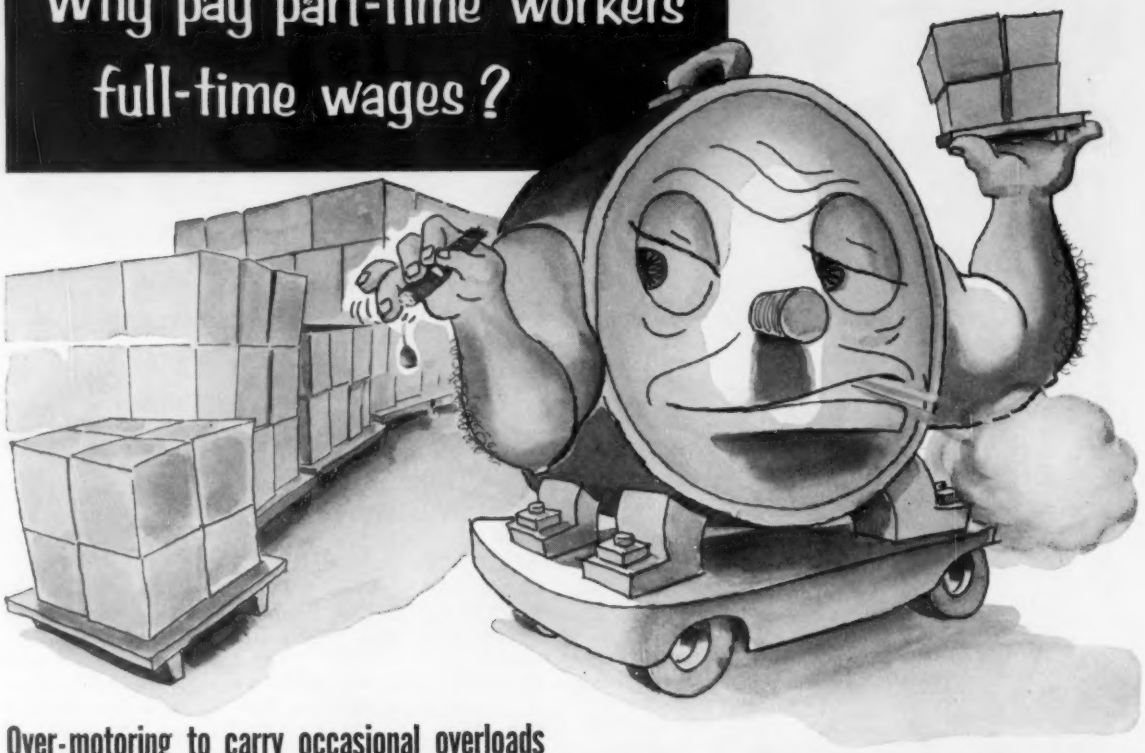
SPAULDING BRANCH SALES OFFICES

Baltimore 18, Md., 123 West 22nd St.
Boston 16, Mass., 585 Boylston St.
Boston Area:
Wellesley Hills 82, Mass., 44 Washington St.
Bridgeport 5, Conn., 2889 Fairfield Ave.
Camden 1, N. J., 227 South Sixth St.
Chicago 25, Ill., 4770 Lincoln Ave.
Chicago 38, Ill., 5604 West 63rd St.
Cleveland 14, Ohio, 2108 Payne Ave.
Cleveland 16, Ohio, 19035 Detroit Rd., Rocky River
Dayton 2, Ohio, 136 So. Ludlow St.
Detroit 1, Mich., 4612 Woodward Ave.
Fort Wayne 6, Ind., 2301 Fairfield Ave.
Lansing 10, Mich., 2021 South Cedar St.
Woodhaven 21, L. I., N. Y., 90-34 Jamaica Ave.
Milwaukee 8, Wisc., 3329 West Vliet St.
New York 55, N. Y., 384 East 149th St.
St. Louis 5, Mo., 7247 Olive Street Road
Tonawanda, N. Y., 310 Wheeler St.
Westfield, N. J. (Newark Area), 101 Central Ave.
Berkeley 10, Calif., 2221 Fourth St.
Los Angeles 15, Calif., 1325 San Julian St.
Toronto 18, Ont., A. A. Andersen & Co., Ltd., P. O. Box 92

SPAULDING FIBRE CO., INC. **310 Wheeler St., Tonawanda, N.Y.**



Why pay part-time workers full-time wages?



Over-motoring to carry occasional overloads is outmoded by silicone insulation!

Once it was standard practice to install motors rated to meet peak loads. But today you can save money by using *silicone insulated* motors to match the *average load*. Their built-in service factor (ranging up to 50%) will carry most intermittent overloads!

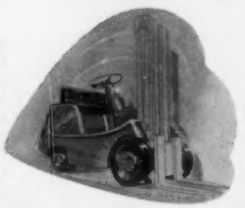
Motors Insulated with Dow Corning Silicones Mean . . .

Lower capital investment and installation costs
For every dollar sunk in unused motor capacity you also waste another $3 in installation and distribution service costs.

More continuous production
Motors insulated with Dow Corning silicones give you maximum resistance to heat, moisture and corrosive atmospheres.

10 years of proof in service!

Automatic Transportation Company has used silicone insulation on all of the lift truck motors they have manufactured since 1946 . . . "because silicone insulation contributes to longer life and can take harder abuse than other insulating materials." In daily service these motors are constantly lifting capacity loads . . . and every time a truck climbs a 2% grade, the torque on its motor is doubled. Yet, according to Automatic Transportation Engineers, in the ten years since adopting silicone insulation . . . "we have never, to our knowledge, lost a motor due to insulation failure."



Use this coupon today!

Dow Corning Corporation, Dept. 4104, Midland, Mich.
Please send me sources of supply for new Silicone (Class H) ☐ Motors ☐ Transformers

NAME _____ TITLE _____
COMPANY _____
STREET _____
CITY _____ ZONE ____ STATE _____

DOW CORNING SILICONES

DOW CORNING CORPORATION
MIDLAND, MICHIGAN

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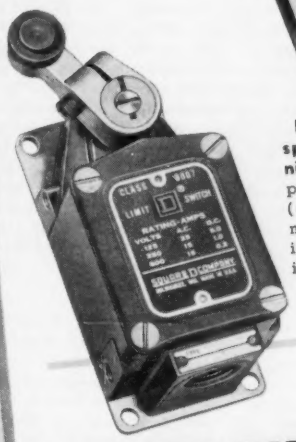
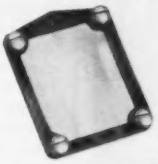
CANADA: Dow Corning Silicones Ltd., Toronto
GREAT BRITAIN: Midland Silicones Ltd., London
FRANCE: St. Gobain, Paris

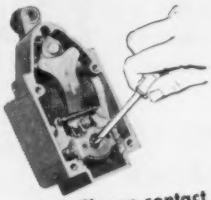
SQUARE D LIMIT SWITCHES

DESIGNED TO DO HUNDREDS OF JOBS... Better!

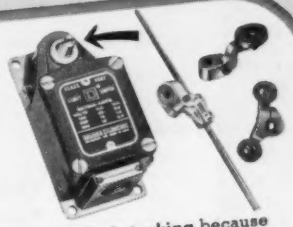




Instant visual inspection of mechanism through transparent plastic cover (optional). A tremendous time saver in multiple switch installations.



Eleven contact arrangements in one switch...and all you need to make the changes is a screwdriver!

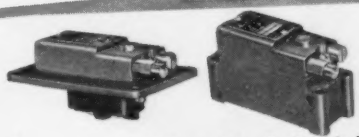


Simplified stocking because basic switches and a wide variety of lever arms are packaged separately. Moderate stock handles a multitude of combinations.

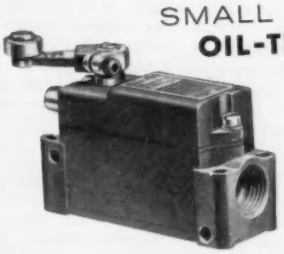
Continuously adjustable operating lever arms permit an infinite number of adjustments. Up to 80° overtravel reduces arm breakage.

Easy mounting and interchangeability through wide variety of base plates and side mounting holes.

HEAVY DUTY
OIL-TIGHT • Class 9007, Type T



SMALL
OIL-TIGHT
Class 9007, Type A



Roller arms are available in a wide range of designs and lengths.

Small precision limit switch available in three forms—basic contact mechanism, flush or surface mounting. Both flush and surface mounting switches are available with varying lengths of roller arms and with rollers of different types and sizes. Also push rod operated (*shown above*) and in single unit or duplex construction.

Write **for Bulletin 9007** *which gives the complete details of Square D's complete line of oil-tight limit switches*

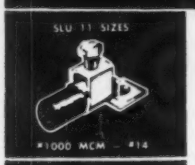
Address Square D Company, 4041 North Richards Street, Milwaukee 12, Wisconsin

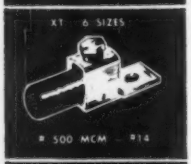
ASK YOUR ELECTRICAL DISTRIBUTOR FOR SQUARE D PRODUCTS

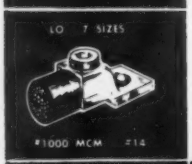
SQUARE D COMPANY

ILSCO CONNECTORS

MAKE YOUR PRODUCT PERFORM BETTER







All these . . . and more . . . for
YOUR BEST CONNECTIONS

U/L AND CSA TESTED	HI-RUGGED STRENGTH
PURE COPPER	RE-USABLE
100% CONDUCTIVITY	ALL WIRE SIZES
COOLER OPERATION	ECONOMICAL

WRITE FOR
80-PAGE CATALOG

ILSCO CORPORATION
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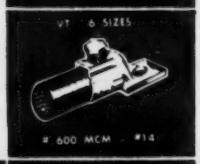

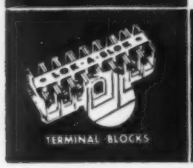

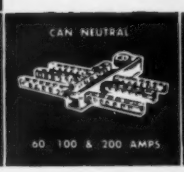

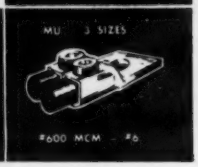

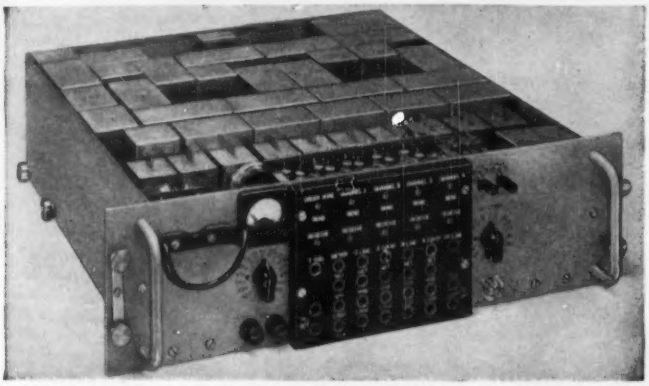

FOUR-CHANNEL CARRIER-TELEPHONE TERMINAL FOR RADIO LINKS

This is a miniaturized unit of advanced design which provides four voice channels on a frequency-division basis above a voice-frequency order-wire channel. Each of these five channels is provided with a 4-wire 2-wire termination and a voice-frequency ringing circuit for d-c or 20-cycle signals. Adjustable attenuators are provided in the 4-wire side of all channels, and a built-in test oscillator and meter permit complete line-up, maintenance and trouble-shooting checks to be made. Channel levels are from −9 to 0 dbm and line levels from −30 to 0 dbm. Channel width is 300 to 3500 cycles within 1 db.

This unit is only 5¼″ high by 19″ wide by 14″ deep. It mounts on a standard rack and operates from 115 volts 50-60 cycles a.c.

RADIO ENGINEERING PRODUCTS
1080 UNIVERSITY ST., MONTREAL 3, CANADA
TELEPHONE UNiversity 6-6887
CABLES RADENPRO, MONTREAL

Industrial Notes

(Continued from page 46A)

proof protection for periods up to two years. It is not a paint, but when applied, gives a thin semitransparent film protection which keeps the metal in plain sight, shining and continually bright for inspection purposes. It is equally effective indoors and outdoors, in either salt or fresh atmosphere. It it ideal for protection of materials in process, in stock or in storage, in addition to application on installed heavy equipment, raw metals, machinery, and the finest of precision parts or tools. For further information, write the Valvoline Oil Company, Freedom, Penn.

High-Current Vacuum Switch. Penta Laboratories, Inc., of Santa Barbara, Calif., has made available the *PL-169* high-current vacuum switch. The *PL-169* was developed for switching between spectrograph arc and spark sources, but has numerous other applications where a compact, sealed relay capable of handling 30 amperes at voltages up to 250, or low current at voltages up to 22,000, or both, is required. The *PL-169* features large contact surfaces, large terminal leads, and a heavy flexible shunt to carry current around the armature. High vacuum exhaust allows the *PL-169* to withstand 22,000 volts across the open contacts, even though spacing is only 0.020 inch.

Portable Transistor Tester. A new, inexpensive, portable transistor tester expected to be a boon for radio and television service technicians and hobbyists has been announced by the General Electric Company. The new instrument was designed to fill the need for a device to determine quickly if a transistor is usable in an electronic circuit when a large laboratory transistor tester is not available. The portable transistor tester is about the size of a pocket radio. It may be used to check all junction transistors for short circuits, opens, leakage, and current gain. To simplify use of the instrument, the meter has two scales. The lower scale, used for determining leakage, is divided into three large sections by different colors. The green section indicates no significant leakage and a usable transistor while the yellow section indicates a borderline unit and the red section, high leakage and therefore an unusable transistor.

Plug-In Adapter. A new Plug-in adapter which greatly extends the use of the Weston model *749* miniature a-c clamp voltammeter has been introduced by the Weston Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark, N. J. This compact adapter has plug receptacles on either side; one of which reduces the scale range of the model *749* by a factor of 10, permitting low-current measurements. The receptacle on the other side is for reading the ampere scale directly (1:1). For measuring the current consumption of motors, appliances and circuits, the adapter is plugged into the a-c

(Continued on page 54A)

Manufactured to the

HIGHEST STANDARDS OF RELIABILITY IN THE INDUSTRY !

SELENIUM POWER RECTIFIERS BY

International

Widest Range in the Industry

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A WORLD OF DIFFERENCE ... THROUGH RESEARCH

Over 75% of America's foremost users of Power Rectifiers specify International! *You* can depend on International's broad experience and versatile manufacturing ability to provide the most practical answers to your rectifier problem. A complete Applications Advisory Department is available to quickly determine the *right* rectifier for your product; the *right* manufacturing process to assure you superior, trouble-free performance. A wire, letter or phone call will bring you an immediate and experienced recommendation for your rectifier application.

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IN CANADA: ATLAS RADIO CORP., LTD., 50 WINGOLD AVE. W., TORONTO, ONTARIO, RU 1-6174

THE WORLD'S LARGEST SUPPLIER OF INDUSTRIAL METALLIC RECTIFIERS

How Rome Synthinol® Control Cables serve Philadelphia Electric at its New Cromby Station

Philadelphia Electric Company, privately owned and an important producer of electrical power, has recently completed its eighth large generating station—Cromby.

The Cromby Station will increase the capacity of Philadelphia Electric's system by 17% to keep pace with booming industrial and residential development of the Delaware Valley.

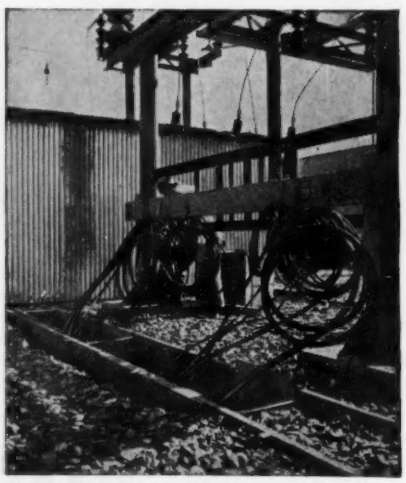
Cromby is a two-unit station. Already in operation is a 150 megawatt steam generator and an additional 200 megawatt unit will be operating by mid-1956.

Over 1,500,000 conductor feet of Rome Synthinol Control Cables were used at Cromby. There are two major applications . . . remote control of high-voltage yard circuits and regulation of the soot blowers. Underground cables for yard control are insulated with Rome Synthinol, rated at 60°C.

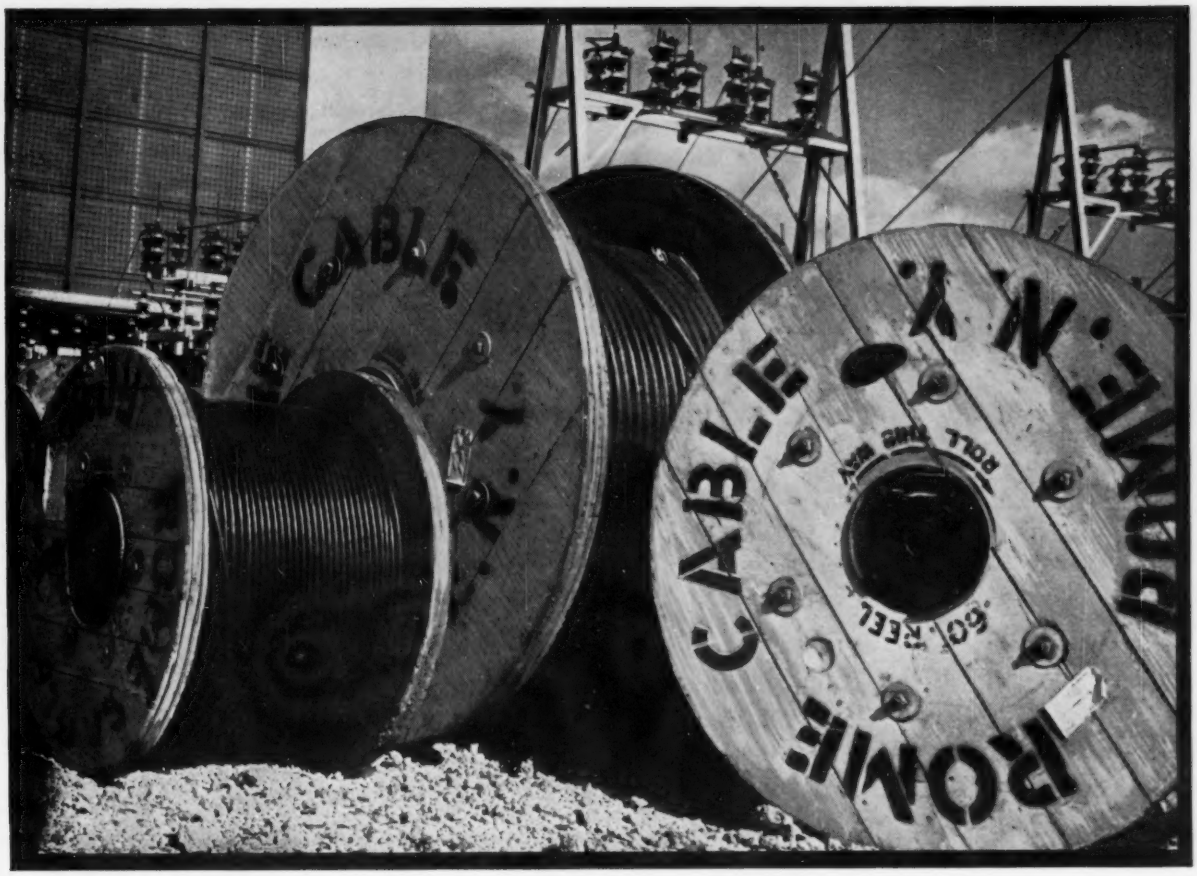
You, too, can specify Rome Synthinol Control Cables with confidence.

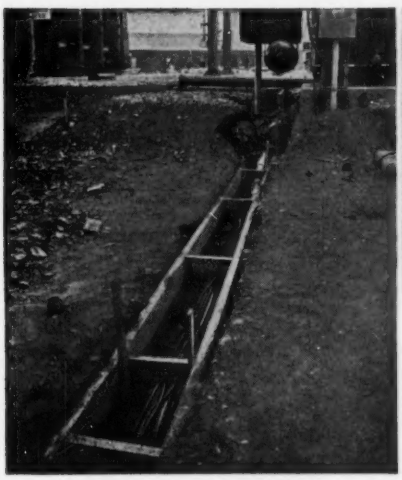
The Cromby story is continued in the picture captions . . .

The development of cables, having multiple conductors under a common nonmetallic sheath, in which Rome has played an important role, has been of inestimable value in station control planning. Not only do they save installation time and costs but provide good mechanical protection, as well.

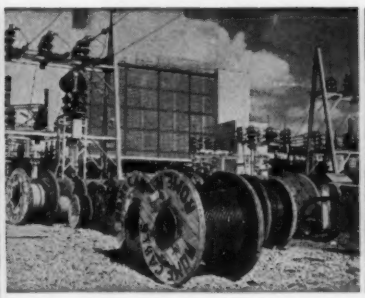


The fundamental application of Rome's product is in control of the 33,000, 66,000 and 132,000 volt yards. There the Rome Synthinol (polyvinyl chloride) insulated and sheathed cable is buried directly in earth.

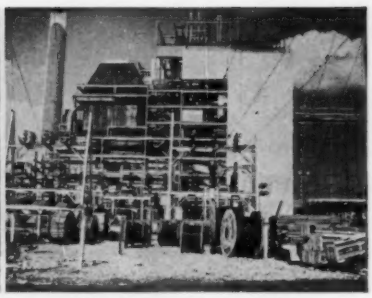




Every factor was weighed carefully before specifying polyvinyl chloride for underground work. Its qualifications fitted two very important requirements at Cromby . . . high resistance to moisture and good dielectric strength.



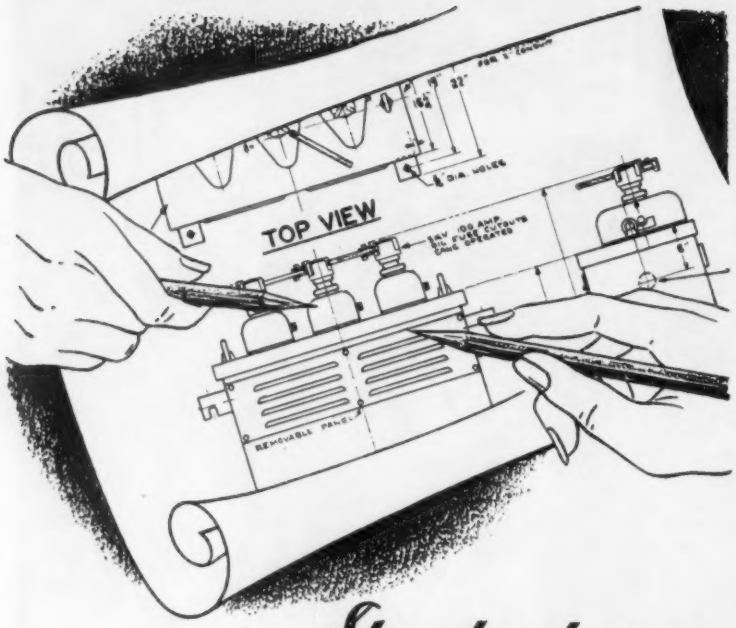
The Rome underground cable at Cromby is expected to last a good many years. Its superior resistance to soil conditions assures long, trouble-free service life.



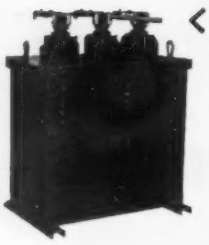
Installation experience under a wide variety of service conditions has proved polyvinyl chloride insulation and sheath to be extremely dependable—more economical than some other constructions.

It Costs Less to Buy the Best

ROME CABLE
Corporation
ROME · NEW YORK
and
TORRANCE · CALIFORNIA

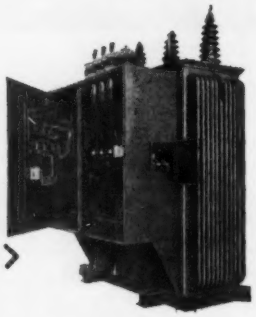


Standard WORKS WITH YOUR ENGINEERS WHEN YOU NEED Special TRANSFORMERS



25 KVA Dry Type Load Center Transformer with primary oil-filled fused cut-outs.

1000 KVA Special Unit Sub-Station — 66,000 to 2400 volts.



Working with you, STANDARD engineers can greatly assist in planning special transformer installations for a specific need in your plant. Experienced STANDARD engineers have an excellent understanding of the particular needs of the electrical industry. Custom-designed and built transformers are their specialty. There's a STANDARD TRANSFORMER representative near you. Call him today!

Standard

THE STANDARD TRANSFORMER COMPANY

WARREN, OHIO

REPRESENTATIVES IN PRINCIPAL CITIES

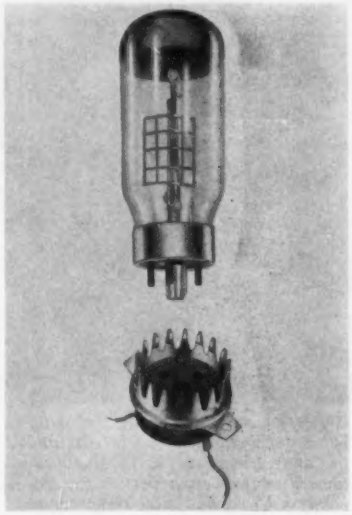
New Products

(Continued from page 50A)

line, the appliance connected to the adapter and the clamping jaws of the instrument inserted through the adapter opening. Voltage readings also are quickly made simply by plugging the probes of the model *749* into the plug receptacles on either side. Complete information on the miniature clamp volt-ammeter and the new plug-in adapter can be obtained direct from the manufacturer.

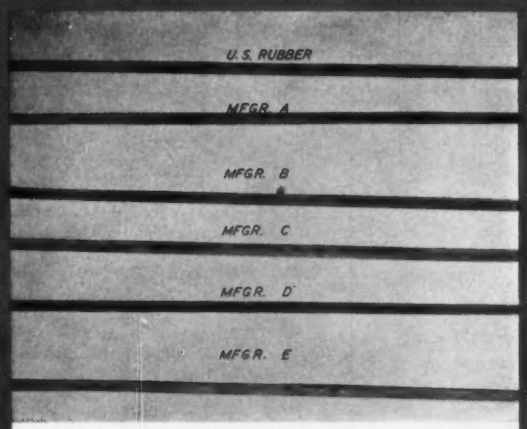
Filter Choke Design and Ratings. A new concept in filter choke design and ratings is effected in the hermetic series released by United Transformer Company (UTC). These hermetic filter chokes are designed to provide exceptional reliability through low temperature rise and high insulation safety factors. Four inductance versus current ratings for each unit provide maximum versatility in application. The 10 units in this *H* series cover current values from 20 MA to 1,250 MA, with voltage ratings up to 3,000 volts d-c. United Transformer Company, 150 Varick Street, New York 13, N. Y.

Projection Lamp. A new type projection lamp which will permit new design concepts in motion picture and slide projectors, has been announced by Sylvania Electric Products, Inc. Providing greater light, the lamp is focused with complete accuracy. Known as Tru-Focus, the projection lamp will burn in any position, including horizontal or base down. For this reason, and because it is compact (4-inches high, including socket), the lamp opens up new fields in projector design. Some of the advantages of the Tru-Focus lamp result from a socket of unique construction which is used with the lamp. Lamps inserted in new sockets automatically snap into perfect prefocused alignment. This provides the perfect alignment with the projector's

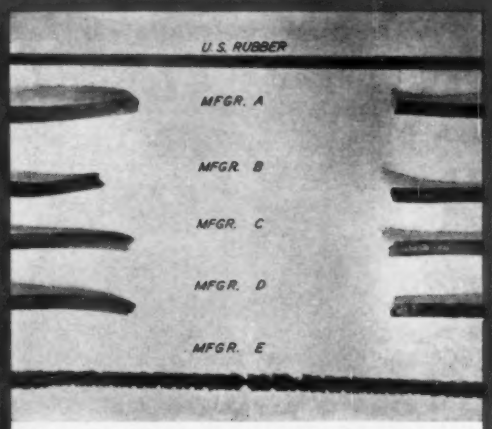


(Continued on page 56A)

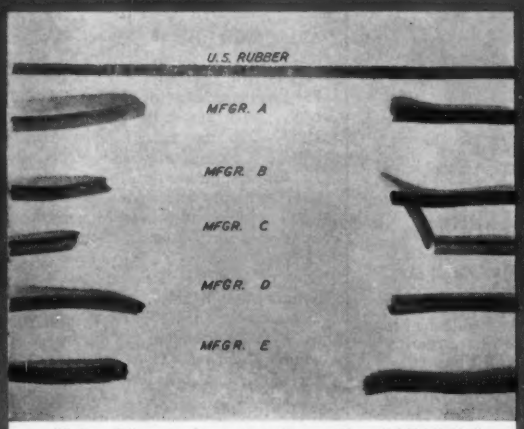
Grizzly High Voltage Power Cables



Here are 6 samples of widely used competitive neoprene jackets (stretched 200% of original length) at start of test for ozone resistance.



2 hours, 23 minutes after start. Brand "E" is disintegrating. Brand "B" has failed 13 minutes ago; the other brands failed an hour or more before.



Taken 7 hours after start of test—Brand "E" failed after 2 hours, 30 minutes. U. S. Grizzly Power Cable's jacket showed practically no sign of damage. It did not fail until after 18 hours of exposure.

Proved far and away the winner in an Ozone test of 6 leading competitive jackets!

U. S. Grizzly® High Voltage Power Cables are unmatched in performance, durability and all-around economy. Order these superior cables from your "U. S." branch, distributor or write Electrical Wire & Cable Department, United States Rubber Company, Rockefeller Center, New York 20, N. Y.

Obsolete wiring can cause power failure, step up expense and push down your production. That's why it's important to make sure your plant is equipped with Adequate Wiring—adequate not only for today's needs but also for the increased electrical loads needed in your future growth.

Electrical Wire & Cable Department

United States Rubber

INDUSTRIAL POCKETSCOPE

by Waterman

MODEL S-11-A

DC-COUPLED WORK-HORSE OF INDUSTRY

Size:
11" x 5" x 7"
8¾ Pounds

ANOTHER EXAMPLE OF Waterman PIONEERING...

The INDUSTRIAL POCKETSCOPE, model S-11-A, has become America's most popular DC coupled oscilloscope because of its small size, light weight, and unique flexibility. This compact instrument has identical vertical and horizontal amplifiers which permit the observation of low frequency repetitive phenomena, while simultaneously eliminating undesirable trace bounce. Each amplifier sensitivity is 0.1 Volt rms/inch. The frequency responses are likewise identical, within —2 db from DC to 200 KC. Their total undistorted outputs permit effective trace expansion of twice the screen diameter. The internal sweep generator is continuously variable from 3 cycles to 50 KC and can be synchronized from positive going signals. Return trace blanking is optional. Intensity modulation is accomplished by connecting either directly to the grid of the three-inch cathode ray tube or thru an amplifier having a gain of approximately 10 and a flat response to 500 KC. Direct intensity modulation threshold voltage is approximately 1 volt rms. Additional provisions for direct access to all the deflection plates, the second anode, and the amplifier output terminals extend the usefulness of the S-11-A many fold.

WATERMAN PRODUCTS CO., INC.

PHILADELPHIA 25, PA.
CABLE ADDRESS: POKETSCOPE

MEMO... Write for details today!

WATERMAN PRODUCTS

MANUFACTURERS OF

PANELSCOPE*
S-4-C SAR PULSESCOPE*
S-3-C LAB PULSESCOPE*
S-11-A INDUSTRIAL POCKETSCOPE*
S-12-B JANized RAKSCOPE*
S-12-C SYSTEMS RAKSCOPE*
S-14-A HIGH GAIN POCKETSCOPE*
S-14-B WIDE BAND POCKETSCOPE*
S-14-C COMPUTER POCKETSCOPE*
S-15-A TWIN TUBE POCKETSCOPE*
RAYONIC* Cathode Ray Tubes and Other Associated Equipment

*T. M. REG.

New Products

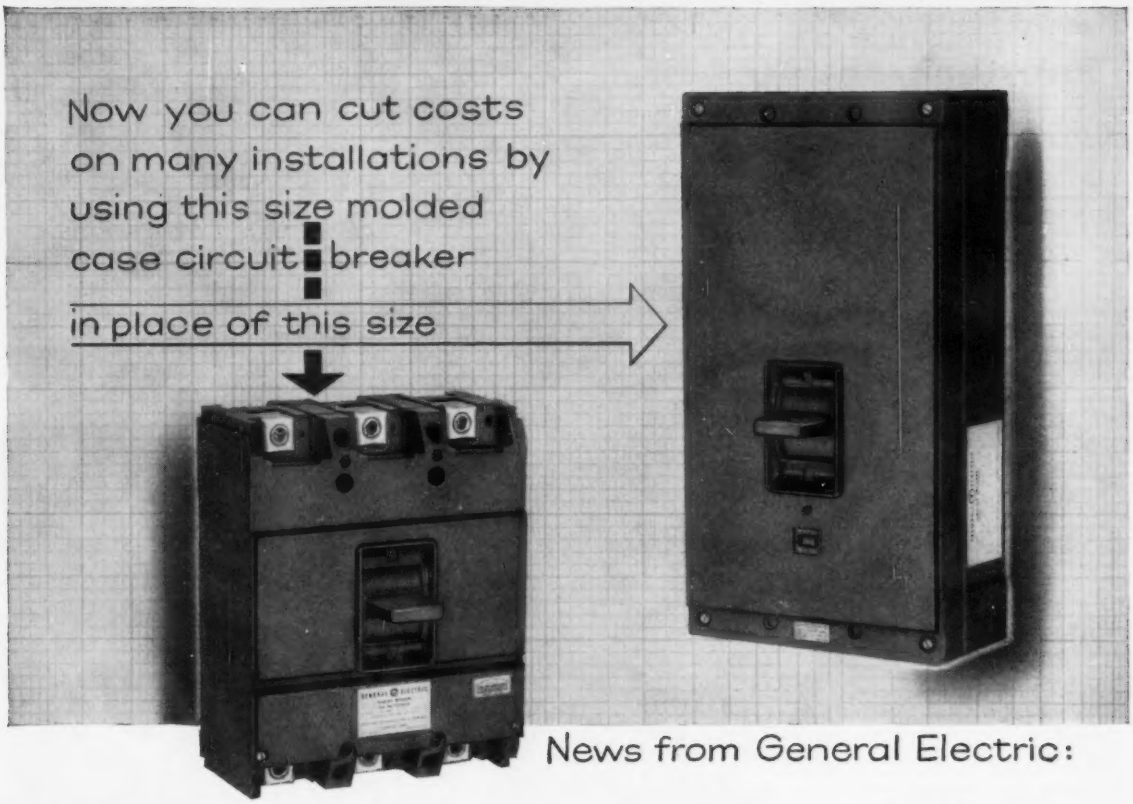
(*Continued from page 54A*)

optical system to assure precision light position. One of the important features of the Tru-Focus lamp is the fact that a lamp has been designed to burn horizontally without blackening the glass envelope. A new grid screen in the lamp directs the air flow inside the lamp. This prevents blistering of the glass and also collects a large part of the lamp-blackening particles which form when any projection lamp burns. This feature keeps the lamp's glass clearer and creates higher lumen maintenance.

Rigid Thin-Walled Class H Bobbins. A silicone glass cloth bobbin laminated into a unified structure is now being produced by Silicone Insulation, Inc., 564 Third Avenue, New York, N. Y. It is finding a most needed application in high temperature transformers, solenoids, relays and other coil using equipment. It replaces types made by assembling two formed halves or cementing two washers to a core tube. Bobbins of this kind are made to customer specifications over a wide range of shapes and dimensions. Laminated silicone glass cloth bobbins meet and exceed Class *H* temperature requirements. For Class *B* and intermediate applications polyester glass cloth or epoxy glass cloth are used.

All Electric Home Socket. A square socket suitable for use with all watthour meters with a capacity of 100 amperes or less has been announced by General Electric's meter department in Somersworth, N. H. The new socket is a significant contribution to ease of wiring, especially for 100 ampere installations—very common in modern homes where wide use of large and small appliances leads to higher consumption of electric power. General Electric calls the product, "The All Electric Home Socket" and has designated it type *S-1*. Symmetrical location of the terminals in the *S-1* provides the same wiring ease whether the socket is for vertical or horizontal mounting. Conversion is simple, as each individual terminal block assembly is secured by two screws. To convert from vertical to horizontal mountings, the blocks are unscrewed and remounted 90° from

(*Continued on page 58A*)



News from General Electric:

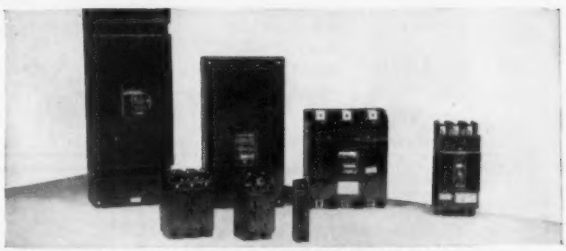
NEW 480-volt I. C. ratings on circuit breakers give you low-cost circuit protection

Formerly contractors and industrial users had to use 600-volt interrupting ratings for circuit breaker applications at both 480 and 600 volts. Now, General Electric offers you new 480-volt Interrupting Capacity ratings for the complete line of G-E industrial circuit breakers (and a 25% increase for the L frame breaker at 240 volts)—and every rating has been tested and proved in the world's largest electrical short circuit laboratory.

In many installations, these new I.C. ratings will allow you to use a smaller General Electric breaker in place of a larger breaker (or even in place of heavier, more costly equipment). You get the same protection for your expensive electrical equipment as before—but at less cost—with G-E molded case circuit breakers.

You get on-the-spot delivery in most cases, too. A new General Electric plan provides for separate stocking of enclosures and breakers by your G-E Distributor. That means you get faster delivery of any of G.E.'s wide choice of circuit breakers in your selection of NEMA 1 and 1A enclosures.

See your G-E Distributor today for full details on the new interrupting ratings and the fast delivery plan! Trumbull Components Dept., General Electric Company, Plainville, Conn.



Here are the new interrupting ratings for G-E circuit breakers:

Frame size	New 480-volt ratings (asymmetrical amperes)	600-volt ratings (asymmetrical amperes)
F frame	15,000	15,000
J frame	20,000	15,000
K frame	25,000	25,000
L frame	35,000	25,000

L frame at 240 volts now has a 50,000-ampere interrupting rating—old rating was 40,000 amperes.

GENERAL ELECTRIC

modernization

For the benefit of those to whom marking pulses and spacing pulses are only assorted bauds — the top illustration represents a venerable, familiar and respected telegraph relay made by one of the great corporations. For a long time it has been common in Teletype communication equipment; and, as with the DC-3 airplane, its "bugs" are pretty well domesticated.

Then, in a 1946 development contract, the Signal Corps asked for a small equivalent — hermetically sealed against the tropics and G. I. fingers. Ironically enough, when it came time to try and sell the result (Sigma Series 7 ▯) nobody had any way of using it unless it fitted existing sockets and cover clamps.

This led to the preposterous but effective arrangement in the second illustration.

There was only one trouble. It had been the custom with the predecessor relay to clean and adjust contacts at infrequent intervals during a long service life. Hermetic sealing, besides somewhat impairing contact life, makes service and adjustment quite impractical. (Some will recall previous mention of the Air Force Captain and his dramatic "small hole treatment." The story was true.) So the verdict on the Series 7 was confused: Good in "tactical" situations; i. e., foxholes; also good in some commercial equipment, but n. g. in other.

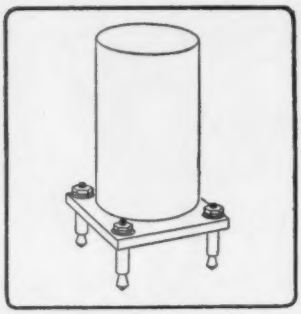
A private attempt to end all such attempts — with a *good* Sigma telegraph relay once and for all — led to the Series 72 [▮]. In order to be sure of *no* distortion at 100 word-per-minute speeds, it was made capable of acceptable behavior at 1000 w.p.m. Not only was it made with a detachable cover, but the wearing parts were made replaceable like phonograph needles. (It was our good fortune that the "72" turned out, in addition, to be a rather decent relay on a great many other counts, which means business outside the telegraph field.)

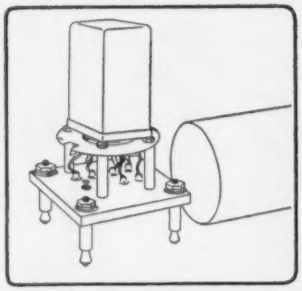
Now, of course, there may be some devil-may-care individuals actually designing future equipment of this type with octal sockets. The AB-37 Adaptor is still around, however, for those who must look before they leap.

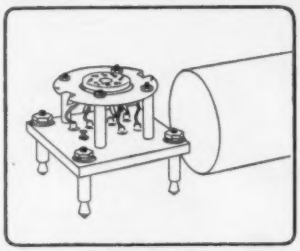
SERIES 72
HIGH SPEED
RELAY

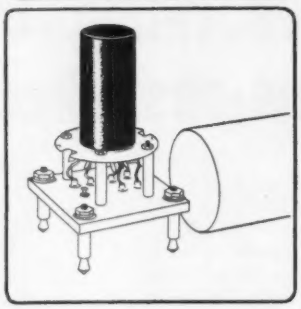
Outstanding Specifications

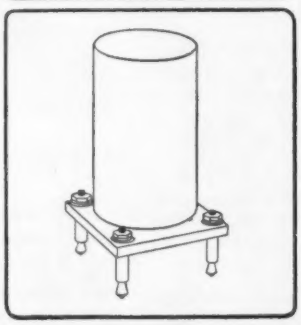
Pulse Relaying	500 per second at 75% efficiency
Life under Load	About 500 million operations without adjustment. (110 V 60 ma. DC simulated printer)
Maintenance	Bias, Sensitivity adjustable; contacts, armature easily replaceable
Vibration Immunity	15 g to 500 cps even unenergized











SIGMA

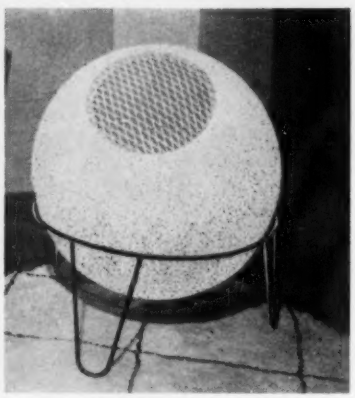
SIGMA INSTRUMENTS, INC., 90 Pearl Street, So. Braintree, Boston 85, Massachusetts

New Products

(Continued from page 56A)

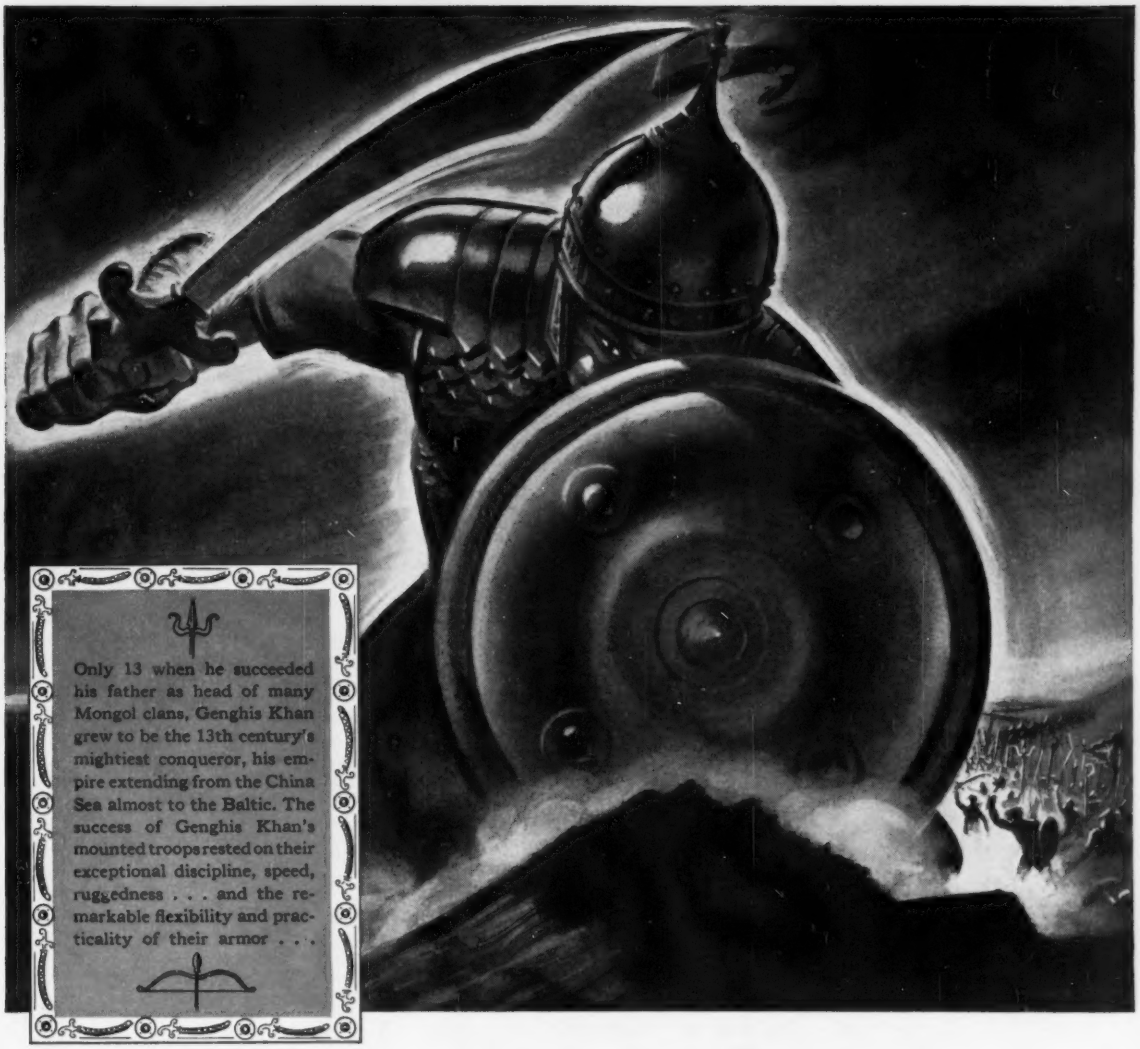
their initial position. The *S-1* socket is approximately $8\frac{1}{4}$ inches square with an inside volume of 144 cubic inches. The over-all depth of the socket and cover is 39/16 inches.

Hi-Fi Speaker System Uses Spherical Enclosure. The Bonn "Sonosphere"—a low-cost high-fidelity loudspeaker system using a sphere of molded plastic as the enclosure has been developed and marketed by Plastilex Products Inc., 6515 North 10th Street, Philadelphia, Pa. Molded of lightweight foam plastic, 18 inches in diameter, the Sonosphere makes a nonresonant infinite-baffle capable of reproducing the entire audio spectrum with full efficiency. The spherical shape eliminates baffle reflections that often interfere with proper cone movement in conventional enclosures, and contributes to exceptionally even, wide-angle sound dispersion of all frequencies. Sound quality can further be tailored to individual tastes simply by turning the Sonosphere so the speaker opening faces toward the ceiling, the floor, or any intermediate position. The wide angle dispersion plus the high power handling capacity of the Sonosphere open up many interesting uses in restaurants, offices, factories, schools, and other commercial sound systems as well as for home hi-fi systems. Since the Sonosphere is plastic, it is not affected by the elements and may be permanently installed out of doors. Complete specifications on the Bonn Sonosphere are available on request.



Hydraulic Marking Unit for Automated Production. The Cadillac Stamp Company has introduced a new hydraulic marking unit, for operation on automated production lines. This unit begins its cycle after receiving a signal from the master control panel and also from the work piece in the proper station. The work cycle consists of clamping, marking, automatic indexing of numbering head unclamping and recording engine serial number on a continuous paper tape. This cycle consumes

(Continued on page 60A)


Only 13 when he succeeded his father as head of many Mongol clans, Genghis Khan grew to be the 13th century's mightiest conqueror, his empire extending from the China Sea almost to the Baltic. The success of Genghis Khan's mounted troops rested on their exceptional discipline, speed, ruggedness . . . and the remarkable flexibility and practicality of their armor . . .

PROTECTED... against constant enemies

Flexibility and *practicality,* important characteristics of armor in Genghis Khan's day, can refer as readily to a modern-day kind of protection—Kerite Cable's never-equalled, never-surpassed insulation. Moreover, Kerite's endurance and resistance to constant attack truly would be a credit to one of those intrepid 13th century Mongol guardsmen.

Kerite Cable has to stand the test of not one enemy, but many—not for days or months, but for 30, 40, 50 and more years. Water, heat, cold, sun, deteriorating elements, time itself—these and more find Kerite an invincible opponent.

Wherever it is used, the world over, Kerite performs perfectly, lasts almost indefinitely. That is the reason wise buyers specify it.

The value and service life of a product can be no greater than the integrity and craftsmanship of its maker.

KERITE CABLE

THE KERITE COMPANY—30 Church St., New York 7, N. Y.
Offices also at 122 S. Michigan Ave., Chicago; 582 Market St., San Francisco;
3901 San Fernando Rd., Glendale 4, Calif.; 31 St. James Ave., Boston

Founded 1854

FOR EXCEPTIONAL
HEAT RESISTANCE
AND GOOD MOISTURE
RESISTANCE
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Wire and Cable
Silicone rubber insulated wire and cable by Collyer is available in ratings from 0 to 5000 volts. Such wire and cable are stable at temperatures up to 200° C, flexible at temperatures down to —60° C and show excellent resistance to corona, oxidation, weathering and many chemicals.
This dielectric — Collyer Silicone — will not be affected by humid atmospheres or severe condensation conditions encountered on cyclic loading operations.
For more information,
phone or write our Engineering Department.
Collyer
COLLYER
INSULATED WIRE CO.
245 ROOSEVELT AVE.
PAWTUCKET, R. I.

New Products

(*Continued from page 58A*)

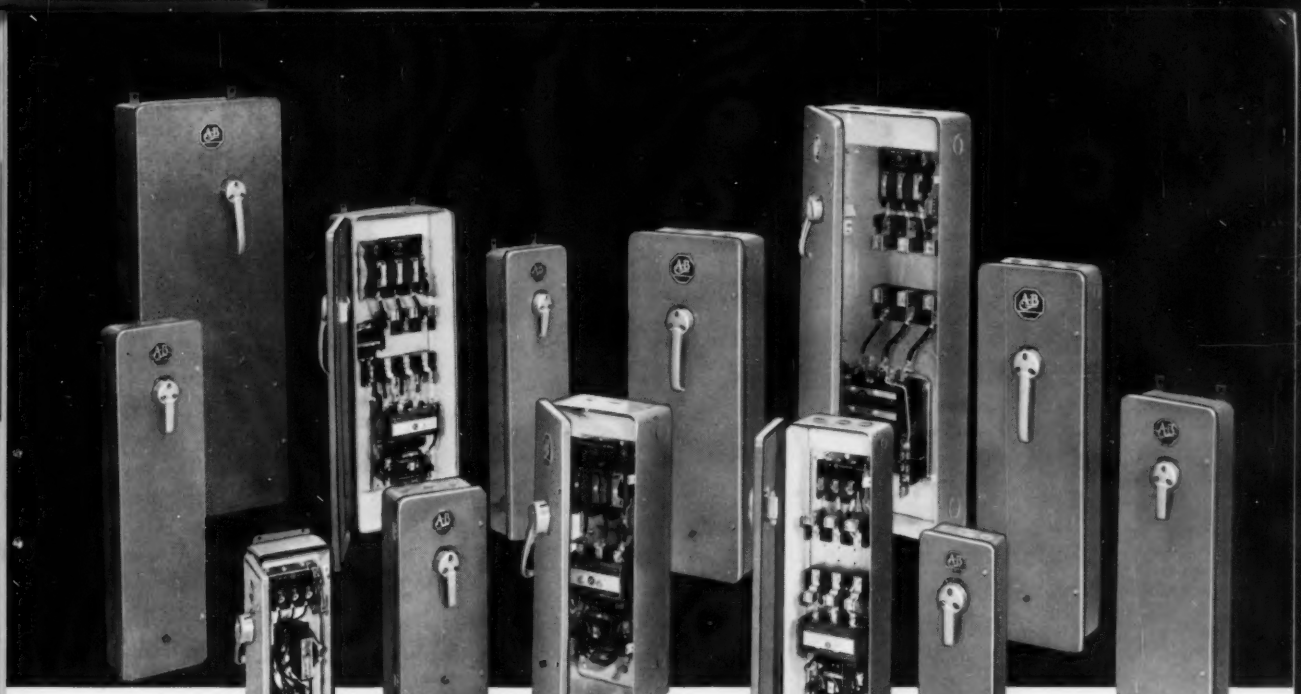
eight seconds. After completion of work cycle, a signal is transmitted to the master control panel and the work piece can be moved out of its station. The marking unit is then ready to resume another cycle. It performs all these functions without the services of an operator. For further information write, Cadillac Stamp Company, 17315 Ryan Road, Detroit, Mich.

Digital-to-Analogue Decoder. The ACF model *1,002* decoder is an all-electronic, rack-mountable converter that provides rapid, precise, and dependable conversion of digital data to analogue voltages. The unit is capable of accepting up to 200,000 ten-bit binary codes per second with a precision of 0.1 per cent. A similar unit is available that provides binary-coded decimal conversion with the same speed and precision. The combination of speed and precision in the model *1,002* decoder makes possible the utilization of the noise-free advantage of digital transmission and the versatility of digital computing techniques with existing analogue-voltage operated display, control, and computing devices. Long-term drift in the decoder is less than 0.3 per cent of the output range because of the use of high precision resistors and chopper-stabilized circuitry. The analogue voltage is corrected to the specified accuracy within 5 microseconds. For further information write to ACF Electronics, Department 204, 800 North Pitt Street, Alexandria, Va.

Green-Yellow Slide Rule Saves Eyes. New light-alloy slide rules made in green-yellow eliminate violet and red rays which focus in front of and behind the retina. The green-yellow shade coincides with optimum sight point of the spectrum, cuts eyestrain, blurring, and errors in reading calibrations. A noncorrosive, non-rusting metal construction eliminates warping swelling, and binding. They are now made in 6 and 10 inch Trig, Log-Log standard rules, or in rules made to special order. Free catalog on request to Pickett and Eckel, Inc., 1109 South Fremont Avenue, Alhambra, Calif.

Aluminum for Electrical Manufacturing. Chrome sealer, Kenvert *40* has solved the problem of aluminum oxidation, therefore making it possible to substitute aluminum for copper in electrical work in protected areas. Conversion Chemical Corporation has developed a sealer which will prevent the oxidation of aluminum when that metal is used in place of copper for electrical purposes. The aluminum is sealed with a film having a very low microhm resistance. The process is simple to use, and the work may be treated in batch processes, or continuously by dip or spray. Treatment time varies depending upon the degree of protection desired.

(*Continued on page 66A*)

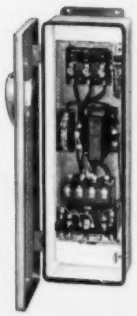


A New Line

OF BULLETIN 712 COMBINATION STARTERS

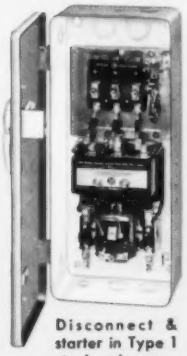
Allen-Bradley announces a modernization of its Bulletin 712 combination starters that should meet with the instant approval of plant "safety" organizations. The cover cannot be opened unless the operating lever is in the "off" position; also the movable disconnect contacts are **plainly visible** when this switch is "open." A welded or sticking contact can be detected instantly. The new operating lever contains a concealed latch pin which permits the maintenance man to open the cabinet without opening the disconnect and stopping the motor. Disconnect switch can be padlocked with three locks—in the open position. It can be arranged for padlocking in running position.

SIZE 1



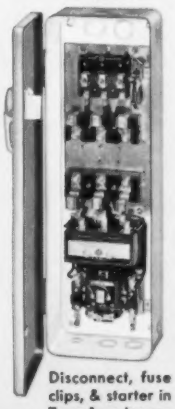
Disconnect, transformer, & starter in Type 12 cabinet.

SIZE 2



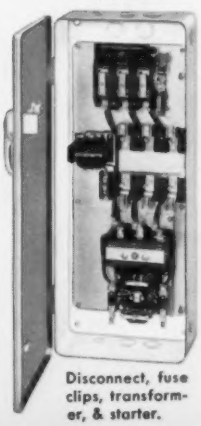
Disconnect & starter in Type 1 steel enclosure.

SIZE 2



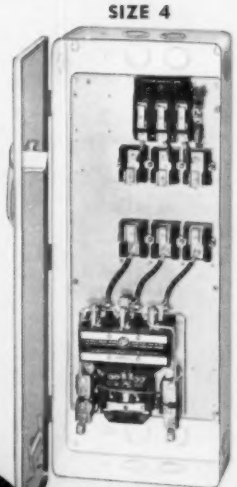
Disconnect, fuse clips, & starter in Type 1 enclosure.

SIZE 3



Disconnect, fuse clips, transformer, & starter.

SIZE 4



Disconnect, fuse clips, & starter in Type 1 enclosure.

Allen-Bradley Co.
1316 S. Second St.
Milwaukee 4, Wis.

In Canada—
Allen-Bradley Canada Ltd.
Galt, Ont.

A-B Quality

ALLEN-BRADLEY

QUALITY

TROUBLE FREE MOTOR CONTROLS

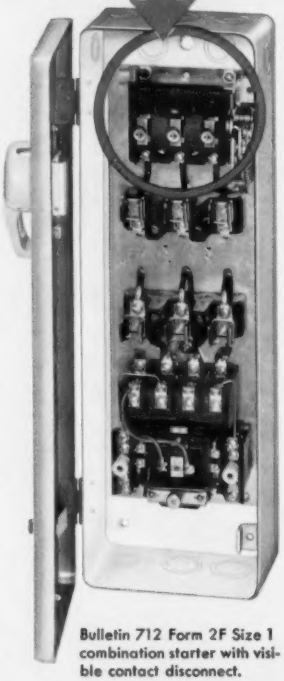
4-56-MR

NEW! The first disconnect switch with movable contacts that are plainly visible in the OFF position

Allen-Bradley has finally succeeded in producing a disconnect switch, which removes all doubt whether the movable contacts are in the "open" or "closed" position. When in the "open" position, they are plainly visible—as open; when in the "closed" position, they are dropped—out of sight in the arc hood.

The moving, double break contacts of the new disconnect (shown in yellow above) move horizontally in individual arc chambers. When the disconnect is CLOSED, the moving contacts are DOWN in the arc chambers. In the OPEN position the moving contacts are UP in plain view, as shown in the colored illustration directly above.

If a contact should stick or weld, it will fail to rise to its "open" position and thereby indicate that the respective "link" remains closed—a plainly visible warning signal to the maintenance man.



Bulletin 712 Form 2F Size 1 combination starter with visible contact disconnect.

A unique feature of the new line are the interlocks built into the disconnect lever.

First—the disconnect lever is interlocked with the door latch so that the door cannot be opened unless the lever is in the OFF position. This assures that the starter is "dead" when the cabinet is open and is safe to inspect.

Second—the disconnect lever has a concealed release pin used only by authorized persons for opening the cabinet door, if needed, without shutting down the motor.

Standard operating lever permits use of one to three padlocks to lock in "off" position, but also can very simply be changed to permit padlocking in "on" position.

These new Bulletin 712 combination starters are available in NEMA Type 1, 4, 7, 9, and 12 enclosures. They are listed from 1 to 100 hp, 220 v; 200 hp, 440-550 v.

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis. • In Canada—Allen-Bradley Canada Ltd., Galt, Ont.

A-B

ALLEN-BRADLEY

TROUBLE FREE MOTOR CONTROLS

QUALITY

4-56-MR

When cemented to caps, top and bottom, this porcelain becomes what is probably the strongest switch-and-bus insulator ever produced.

Illustrated in the production of this unit is a noteworthy and valuable characteristic of the Lapp Post design. The simplicity of the structure, the uniform reliability of Lapp porcelain, and the certainty of cemented caps, instead of pins or inserts, all are such that it is routinely possible to design an insulator into an unexplored strength field. And it will meet specified characteristics, without risk of unknown variables.

In this case, specified cantilever strength requirement was 10,000 pounds. Because time was short, we designed for a generous factor of safety—and obtained all of it. The porcelain is 11½″ diameter, 13⅜″ high, and weighs a little over 60 pounds. It is, of course, the traditional Lapp Station Post closed end porcelain, with integral top diaphragm.

HOW MUCH STRENGTH DO YOU NEED IN A SWITCH-AND-BUS INSULATOR?

In the Lapp plant, such porcelains as this are almost commonplace. Everywhere you look you will see pieces with the characteristic Post corrugations, in all stages of production, and in sizes for duty over a wide range of voltages and strengths. And every unit will be proved, through extensive testing facilities, to its specification requirements. No where else will you find such emphasis, such devotion, to "difficult" porcelains.

Users of Lapp porcelain—as components of electrical equipment, or as insulators for transmission or station duty—profit, in security, in long life, in low upkeep, from the experience and skill born of such design and production.

Lapp Insulator Co., Inc., Le Roy, N. Y.

For fewer outages... without sacrificing protection

Here are two well-liked and widely used KEARNEY *specialized* fuse links:

TYPE KS . . . specially developed to protect and yet keep outages to a minimum on circuits subject to switching and lightning surges . . . can carry overloads up to 150% indefinitely without damage to fuse link or cutout.

TYPE X . . . specially developed to keep transformers in service during overloads and surges . . . yet always interrupting current before the damage range of the transformer is reached. Opens 230% of rated load within five minutes.

ALSO . . . TYPE K—the EEI-NEMA standard fast fuse link . . . **and TYPE T**—the EEI-NEMA standard slow fuse link.

you need KEARNEY

SPECIALIZED FUSE LINKS

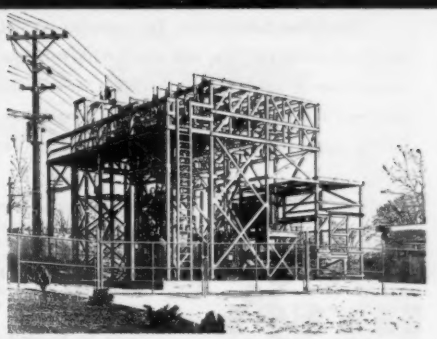
It stands to reason that average "fast" and "slow" fuse links cannot meet all the specific needs of your circuits. For safe operation with an absolute minimum of annoying outages, you need *specialized* KEARNEY fuse links. They're precision-engineered . . . with *matched* time-current characteristics . . . making possible easy and accurate coordination.

LINEMEN LIKE the time-saving, trouble-saving KEARNEY pull-tab Fuse-Pak . . . helps them select the right link quickly and accurately . . . even with gloves on. All KEARNEY Fuse-Paks are color-coded to save time and prevent mistakes.

JAMES R. KEARNEY CORPORATION
4224-42 CLAYTON AVENUE · ST. LOUIS 10, MISSOURI
Canadian Plant: GUELPH, ONTARIO

FUSE LINKS FIELD TESTED . . .

Here at KEARNEY's 450,000 KVA Substation Laboratory all equipment is tested under rigorous field conditions, KEARNEY Certified Ratings are actual, proved performance ratings . . . not just theoretical calculations. You can be sure they will do the job they are supposed to do . . . with a generous margin of safety.

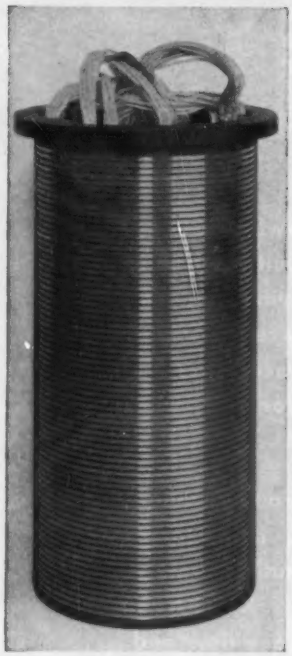


311

for BETTER CONSTRUCTION
SAFER MAINTENANCE
Specify KEARNEY PRODUCTS
The Mark of Quality

ELECTRO TEC *Corporation*

Manufacturers



Slip Ring Assemblies of HYSOL 6000 EPOXIDE RESINS

The Electro Tec Corp. selected HYSOL 6000 Series tubes to make slip ring assemblies. That's because the outstanding electrical, thermal and mechanical properties of HYSOL 6000 epoxide compounds provided an ideal material for precise machining, intricate silverplating and ease of handling. The ability to withstand wear contributed heavily to its use in a mechanism for the transfer of electrical current from a stationary to a rotating mechanism.

Houghton Laboratories, Inc., supplies HYSOL 6000 Series tubes in certain sizes to Electro Tec Corp. and also furnishes the basic resin compound for formulating tubes in varying sizes. The 6000 Series includes a complete line of easily machined sheets, tubes and rods, room temperature and heat curing potting and casting compounds and coating and laminating varinshes.

PROGRESSIVE PRODUCTS HYSOL Product of HOUGHTON LABORATORIES, INC. THRU CHEMICAL RESEARCH

Again, HYSOL 6000 Series epoxide compounds show a remarkable adaptability for a variety of applications. Perhaps one of your design or production problems can be solved with the use of this new plastic. Remember, complete research, design and production facilities at Houghton Laboratories, Inc., are ready to help you in any such problem. Inquiries are invited at no obligation. Learn for yourself what HYSOL 6000 Series compounds might be able to do for you. Phone, wire or write today!

houghton laboratories, inc.

105 HOUGHTON AVE.
OLEAN, NEW YORK

(*Continued from page 60A*)

TRADE LITERATURE

Mandex Issues First Catalogue. A 60-page illustrated catalogue of Mandex electronic components has been published giving designers and engineers full information, drawings, and specifications on molded and laminated tube sockets, terminal strips, lugs, and plugs. Copies of the catalogue are available without charge from Mandex Manufacturing Company, Inc., 2608 West 16th Street, Chicago, Ill.

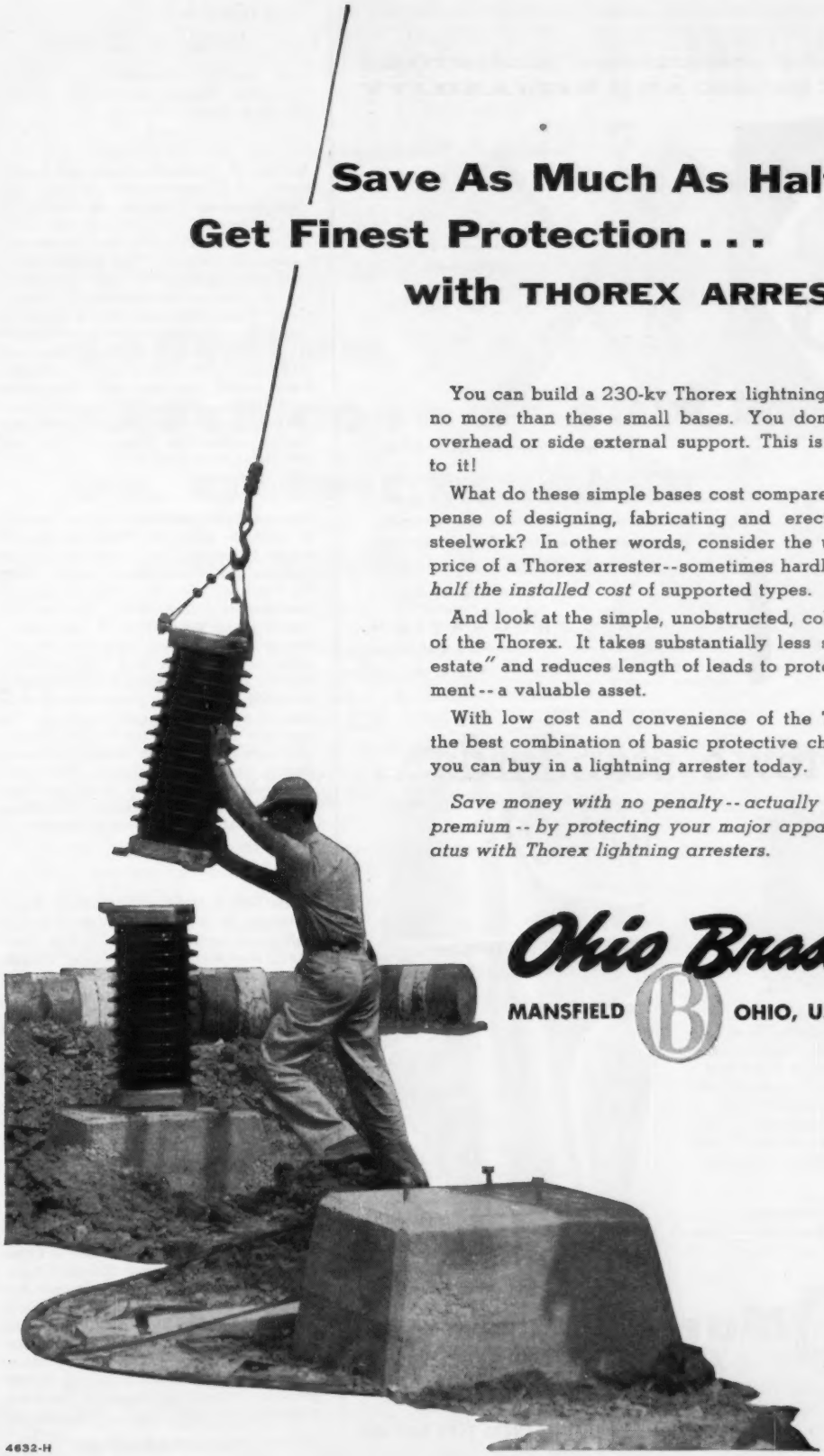
Electroplating Data Chart. A time-saving chart is being distributed by Technic, Inc., for the purpose of saving the electroplater time usually consumed in consulting various tables, and in order to insure him against errors. The new Technic chart provides, at a glance, all related and comparative data on gold, rhodium, palladium, platinum, silver, and nickel. The information correlated by Technic has been compiled in a single convenient reference unit, which uses color strips to minimize the risk of confusion in hasty reading of the chart. It is sized 8 1/2 by 11 inches and perforated for stringing plus margin for ring binding to permit easy inclusion in any standard notebook. The Precious Metal Electroplating Data chart is the latest addition to the Technic series of publications which assemble and correlate specialized material as a service to precious metal electroplaters. Copies are available on request from Technic Inc., 39 Snow Street, Providence, R. I.

Panelboard Catalogue Includes Engineering Data. A new 75-page panelboard catalogue, number *3-205*, that includes 20 pages of engineering data pertinent to panelboard installation and selection has been published by Federal Pacific Electric Company, 50 Paris Street, Newark, N. J. The catalog, entitled "Modern Panelboards," is illustrated with photographs, drawings, diagrams, and specifications describing the features and construction of each panelboard as well as applications. Circuit breakers and fusible disconnect devices used in lighting and distribution panelboards are described, too. It is available through Federal Pacific representatives throughout the United States.

Manual on Keystone Heat-Resistant Cables. A 48-page data book on Keystone heat-resistant cables has been released by the Hazard Division of The Okonite Company. Typical tests results are given for Keystone butyl rubber insulation under conditions of high heat and extreme moisture. Also included are dimensional tables for power and control cables for direct burial and duct use as well as 24 pages of valuable engineering information helpful in selecting and applying the proper cable to the specific job. A free copy of this

(*Continued on page 68A*)

Save As Much As Half . . .
Get Finest Protection . . .
with THOREX ARRESTERS



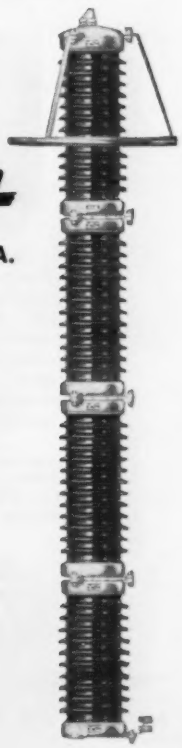
You can build a 230-kv Thorex lightning arrester on no more than these small bases. You don't need any overhead or side external support. This is all there is to it!

What do these simple bases cost compared to the expense of designing, fabricating and erecting special steelwork? In other words, consider the ultimate low price of a Thorex arrester--sometimes hardly more than *half the installed cost* of supported types.

And look at the simple, unobstructed, columnar form of the Thorex. It takes substantially less station "real estate" and reduces length of leads to protected equipment--a valuable asset.

With low cost and convenience of the Thorex goes the best combination of basic protective characteristics you can buy in a lightning arrester today.

Save money with no penalty--actually a premium--by protecting your major apparatus with Thorex lightning arresters.

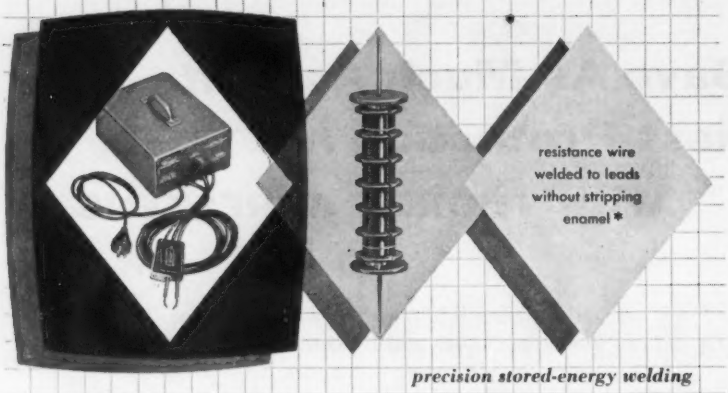


Ohio Brass

MANSFIELD OHIO, U.S.A.

4632-H

TERMINATE PRECISION RESISTORS WITH SPEED AND RELIABILITY



resistance wire welded to leads without stripping enamel *

precision stored-energy welding

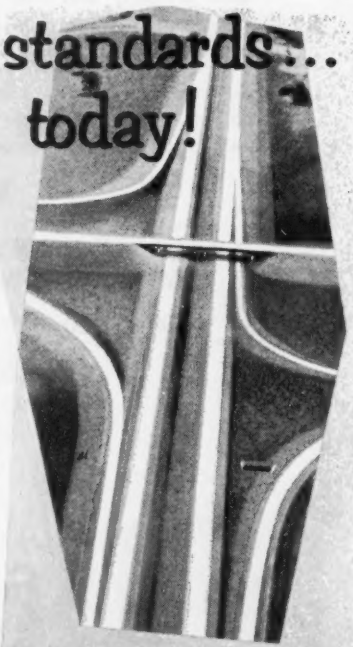
WELDMATIC MODEL 1012 TWEEZER TYPE WELDER welds fine wire to leads or tabs while resistor is on winder. Enamel stripping and flux contamination eliminated, with production time halved. Welded connection is very positive, stable, and rugged.

*Made by Ircal Industries (subsidiary IRC)

Unitek WELDMATIC

UNITEK CORPORATION
261 Halstead Avenue • Pasadena 8, California
Write for Complete Technical Information on Stored Energy Welding

tomorrow's standards... today!



The Ohio Turnpike is the newest link in a national chain of superhighways that will eventually tie East to West. The most modern concepts of traffic engineering are reflected in the construction of this magnificent road. What transformers are used for service and lighting? Marcus, of course!

Electrical contractors:
Amon Electric Co., Warren, Ohio
Peterson-Webster Electric Co.
Youngstown, Ohio

Marcus TRANSFORMER CO., Inc.
RAHWAY, NEW JERSEY
Representatives in Principal Cities

"Mark of Quality"

A COMPLETE LINE OF DRY TYPE AND LIQUID-FILLED TRANSFORMERS THRU 5000 KVA

Trade Literature

(Continued from page 66A)

book may be obtained by writing to: "Keystone," Hazard Division, The Okonite Company, Passaic, N. J.

Booklet on Synthetic Fluids and Lubricants. A 52-page booklet on Ucon synthetic fluids and lubricants has been issued by Carbide and Carbon Chemicals Company, a Division of Union Carbide and Carbon Corporation. The booklet covers properties, applications, and characteristics of these polyalkylene-glycol derivatives. Ucon fluids and lubricants have a multitude of established uses as mechanical lubricants, hydraulic fluids, rubber and textile lubricants, heat-transfer fluids, antifoam agents, solvents, and formulation components. Copies of the booklet, Form *6,500D*, are available from Carbide and Carbon Chemicals Company, 30 East 42d Street, New York, N. Y.

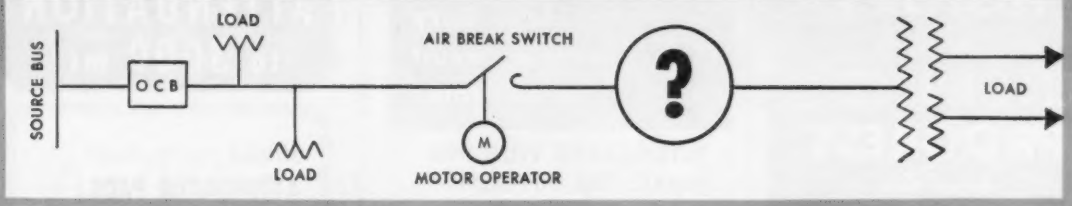
Aircraft Radio Bulletin. A new bulletin is available from the Stoddart Aircraft Radio Company, Inc., clarifying certain little-understood portions of United States Air Force and Navy Bureau of Aeronautics specification *MIL-I-6181B*. The bulletin describes the application of radio interference—field intensity measuring equipment in accordance with *MIL-I-6181B*. Specific instructions and practical examples are cited, including a perspective illustration of a typical equipment set-up. An appendix to this bulletin includes important data on bandwidth concepts in interference measuring equipment. This valuable bulletin is available at no cost from the Stoddart Aircraft Radio Company, Inc., 6644 Santa Monica Boulevard, Hollywood, Calif.

Louis Allis Bulletin. "Louis Allis Rapid Reversing Motors," is the title of a new bulletin released by The Louis Allis Company, manufacturers of electric motors, drives, and generators. Featured in the bulletin is a cutaway view showing the construction of a blower-cooled, rapid-reversing motor capable of more than 200 idle reversals per minute. Engineering information given consists of formulas on inertia and motor reversal calculations. This information will be useful to anyone who has a use for this type of motor. Copies of this informative new bulletin, number *1800*, can be obtained by writing to The Louis Allis Company, Milwaukee 7, Wis.

Science Research Associates Offer Catalogue. A comprehensive 112-page catalogue has been published by Science Research Associates (SRA), 57 West Grand Avenue, Chicago, Ill., listing more than 700 tests, guidance booklets, reading development materials, and the complete services of SRA's consulting and Survey Divisions. Complete with a glossary, booklet guide, and a table of contents, the

(Continued on page 72A)

HOW WOULD YOU PROTECT THIS TRANSFORMER ?



SOUTHERN STATES TYPE HRS SAVES COST OF EXPENSIVE OIL CIRCUIT BREAKER

The problem presented in the schematic diagram above is to provide adequate internal fault protection for a power transformer. One solution would be to install a high side oil circuit breaker. However, this represents a large capital outlay—and, under many conditions, might not be justifiable.

The most practical solution would be to use the source breaker to clear the line should a damaging fault condition develop in the transformer; however, in the above case, transformer impedance is great enough to limit current to values below trip settings for the source breaker relays.

The answer is to install Southern States Type HRS Automatic High Speed Short Circuiting Switch. As soon as such a fault condition develops, the Type HRS, tripped by differential relays, imposes a deliberate ground fault on the line. The source breaker opens, clears the line, and the transformer is protected.

In order to isolate the transformer from the feeder, it is customary to install an air switch on the feeder between the short circuiting switch and the source breaker. Service continuity on the remainder of the feeder, after the HRS operates, can be maintained by providing the air switch with a spring or motor operator. Suitable under-voltage timing relays will automatically open the air switch during a delayed breaker reclosure, restoring service to the line at once.

For a low capital investment and reliable protection, choose the Type HRS. Complete details are available in Bulletin 55 HRS.

Available in Voltage Ratings of 34.5 KV through 161 KV and momentary current ratings of 20,000 amperes and a 4-second rating of 12,600 amperes.

SOUTHERN STATES EQUIPMENT CORP.
HAMPTON, GEORGIA

IN CANADA: Dominion Cutout Co., Ltd., Toronto

CASE HISTORY of an ENGINEER'S PROGRESS from the personnel files of HAMILTON STANDARD

Edward Wallace*

Graduate of Penn State, B.S. Aeronautical Engineering

7/11/49	Engineering Training Course
1/1/50	Junior Installation Engineer
2/16/50	Engineering Training — Post Graduate study at Rensselaer Polytechnic Inst.
7/16/50	Installation Engineer B
10/16/51	Installation Engineer A
7/1/52	Senior Installation Engineer
7/1/55	Assistant Project Engineer

**Actual Case History — change in name only*

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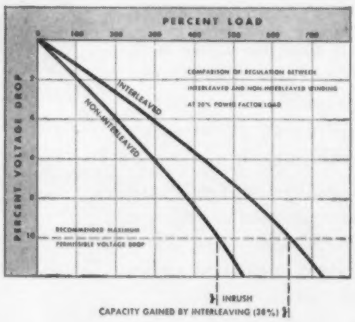
DIVISION OF UNITED AIRCRAFT CORPORATION
46 Bradley Field Road, Windsor Locks, Connecticut

38 percent more capacity with this Hevi Duty control circuit transformer

INTERLEAVED WINDING MAKES THE DIFFERENCE

Type SIO, maximum primary voltage, 600 V



This chart shows that at maximum permissible voltage drop, a Hevi Duty Transformer can handle 38 percent more inrush current than non-interleaved units. This advantage varies from 30 to 80 percent depending on size and design of the transformer.

In addition to superior performance, the higher inrush capacity often enables you to use a smaller size. You then save panel space as well as over-all cost.

Perhaps you can take advantage of the saving that Hevi Duty construction offers. Write for Bulletin T5111 for further data and regulation curves, or send us your requirements.

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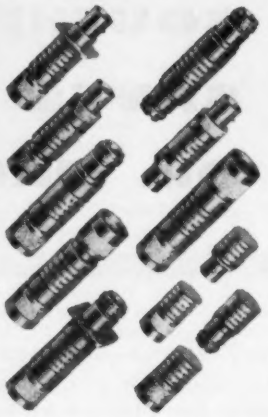

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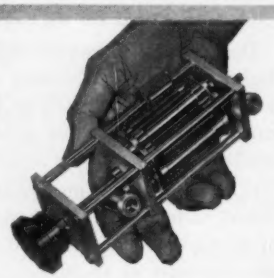
This new group of pads and terminations features the popular Types C and N connectors, and permits any conceivable combination of the two styles.



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STODDART
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6644-B SANTA MONICA BLVD.
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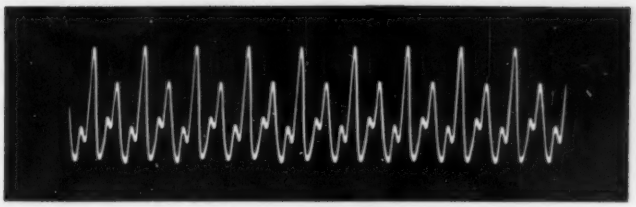
An intrstng exprmnt in spch

Some day your voice may travel by a sort of electronic "shorthand" when you telephone. Bell Laboratories scientists are experimenting with a technique in which a sample is snipped off a speech sound—just enough to identify it—and sent by wire to a receiver which rebuilds the original sound. Thus voices can be sent by means of fewer signals. More voices may economically share the wires.

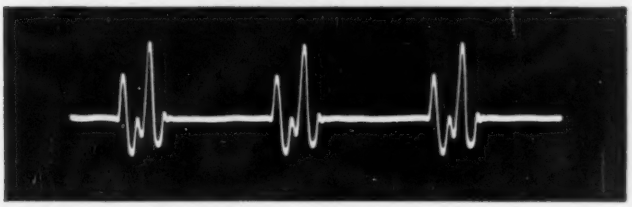
This is but one of many transmission techniques that Laboratories scientists are exploring in their search for ways to make Bell System wire and radio channels serve you more efficiently. It is another example of the Bell Telephone Laboratories research that keeps your telephone the most advanced on earth. *The oscilloscope traces at right show how the shorthand technique works.*

BELL TELEPHONE LABORATORIES

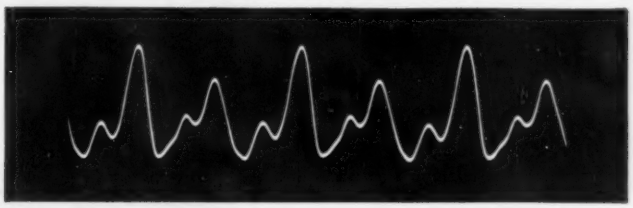
World center of communications research
Largest industrial laboratory in the United States



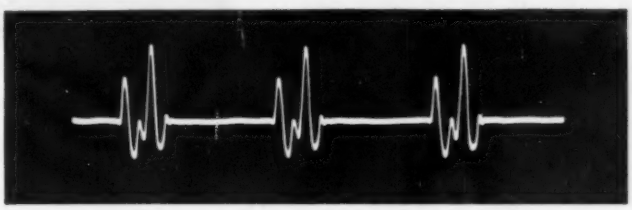
Vibrations of the sound "or" in the word "four." Pattern represents nine of the "pitch periods" which originate in puffs of air from the larynx when a word is spoken.



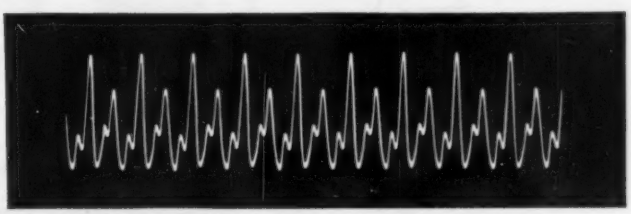
An electronic sampling of the "or" sound. One "pitch period" in three has been selected for transmission. This permits great naturalness when voice is rebuilt. Intelligible speech could be sent through a 1 in 6 sampling.



The selected samples are "stretched" for transmission. They travel in a narrower frequency band than complete sound.



Using the stretched sample as a model, the receiver restores original frequency. In all speech, sounds are intoned much longer than is needed for recognition—even by the human ear. Electronic machines perform recognition far faster than the ear.



The receiver fills in gaps between samples, recreating total original sound. Under new system, three or four voices could travel at once over a pair of wires which now carries only one—and come out clearly at the end!

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- a large staff of engineering specialists
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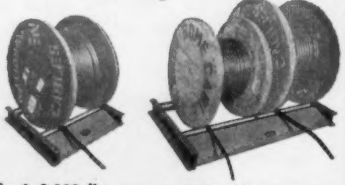

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Trade Literature

(*Continued from page 68A*)

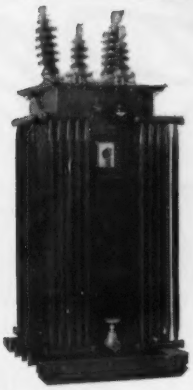
new catalogue utilizes the theme "Progress in Education." New tests, booklets, and services are outlined for the reader. Complete descriptions of all items, and suggestions for setting up reading and guidance programs are given.

Booklet on the Repair of Cast Iron Parts. A new 4-page booklet entitled, "The Repair of Cast Iron Parts," has been issued by The International Nickel Company, Inc. It outlines the latest information on the welding of cast iron with Ni-Rod and Ni-Rod *55*. Nine graphic case histories show the welding electrodes in action. The booklet is available, without charge, through the Readers Service Section, The International Nickel Company, Inc., 67 Wall Street, New York, N. Y.

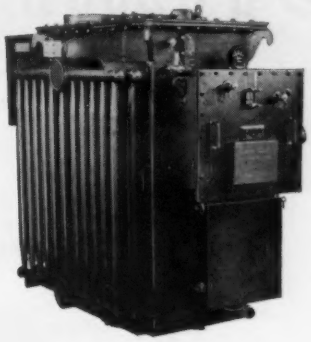
Powder Metallurgy Bibliography Available. A bibliography of current periodical references to powder metallurgy has been prepared by the Harper Electric Furnace Corporation, Buffalo, N. Y., manufacturer of continuous sintering furnaces. The publication refers to nearly 250 articles and papers printed in more than 50 United States, British, and Canadian technical journals, trade magazines, and business papers during 1954 and 1955, with a few selected earlier references.

1956 Audio Catalogue Available. "1956 High Fidelity Audio Guide," a 132-page catalogue of audio equipment has been issued by Terminal Radio Corporation, New York distributor. The booklet illustrates and describes Terminal's complete selection of high-fidelity phonograph equipment, tuners, amplifiers, speakers, cabinets, and tape recorders; also microphones and public address equipment. Free copies may be had by writing to Terminal Radio Corporation, 85 Cortlandt Street, New York, N. Y.

Technical Data on RCA Photosensitive Devices and Cathode-Ray Tubes. Publication of a new 24-page catalogue, "RCA Photosensitive Devices and Cathode-Ray Tubes," has been announced. The catalogue contains technical data on 45 types of phototubes, six types of television camera tubes, and 56 types of cathode-ray tubes; and includes tabular data and a socket-connection diagram of each tube type. Treated under phototubes are single-unit, twin-unit, and multiplier types together with their spectral-response characteristic curves and detailed dimensional outlines. The camera-tube section contains data and spectral response curves for iconoscopes, image orthicons, and vidicons. Covered under cathode-ray tubes are oscillograph types; transcriber, viewfinder, monitor, and projection kinescopes; flying-spot types; monoscopes; computer storage tube; and a brief description of the features of each type of phosphor used in the tubes. This booklet is available from RCA Tube distributors or from Commercial Engineering, RCA Tube Division, Harrison, N. J., at a cost of 20 cents a copy.



The engineering design of Uptegraff Distribution Transformers, representing the most advanced practices, assures dependability of this 500 KVA, 34.4 KV unit.



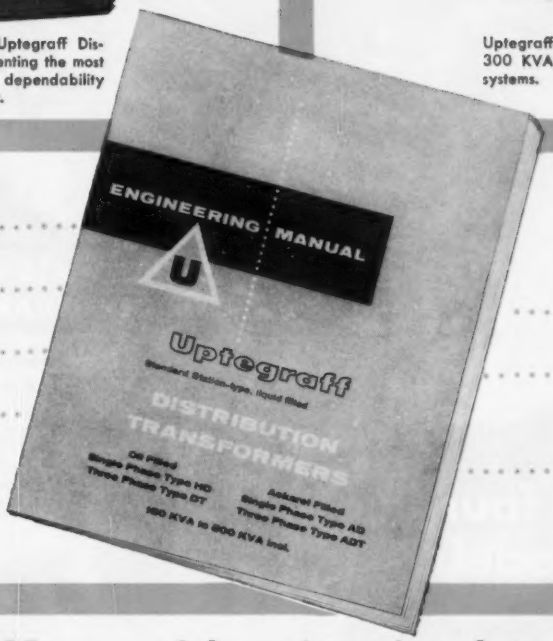
Uptegraff Network Transformer, type NADT, 300 KVA, for urban underground network systems.

ratings ..... efficiencies

dimensions ..... performance data

accessories ..... terminal arrangements

weights .....



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May we send you a free copy of the new bulletin illustrated above? It contains detailed specifications and complete data on Uptegraff liquid filled distribution transformers, 150 to 500 KVA inc. The ratings, performance data, dimensions, weights and other information will be found useful in planning new power systems or in extensions and modernization of present equipment. Outline drawings give all critical dimensions for single phase or three phase transformers, oil and askarel immersed. Various terminal arrangements are shown, and terminal dimensions are given in detail.

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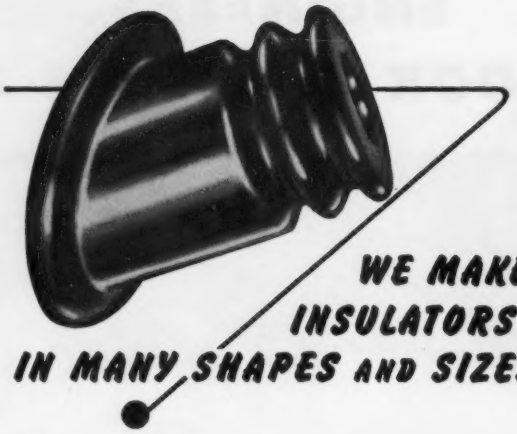

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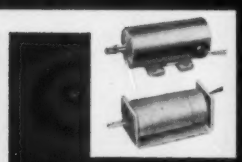

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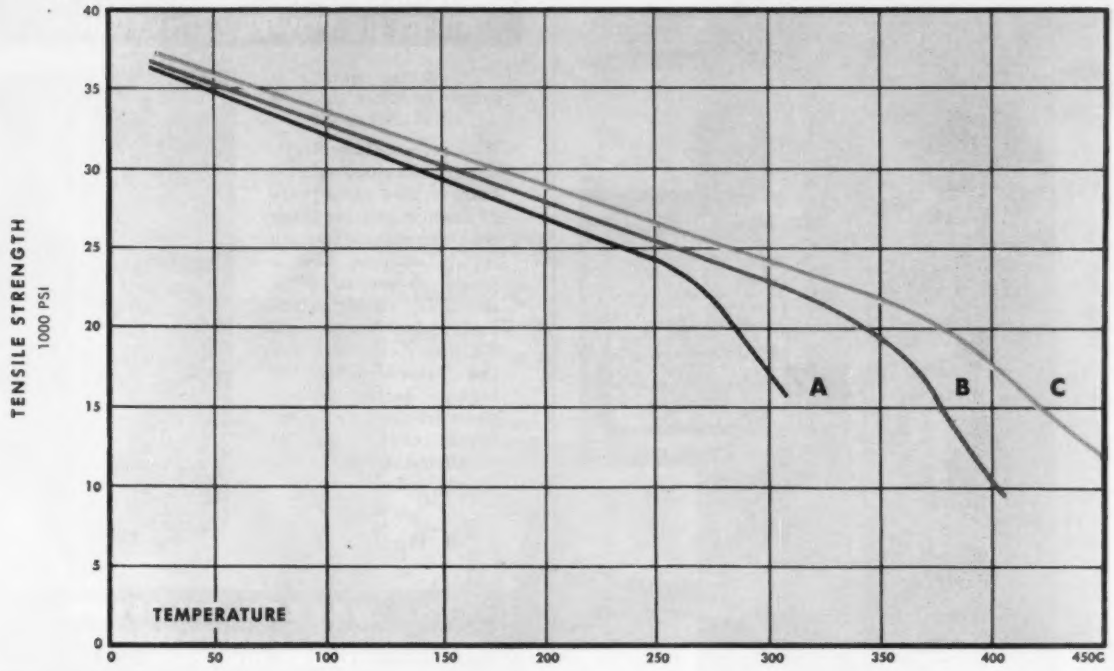
Are you a registered Professional Engineer? .....

4-56

How silver helps copper conductors at elevated temperatures



THE INFLUENCE of silver on the tensile properties of high-conductivity copper at elevated temperatures. Tests made by the Metallurgical Research Laboratory of The American Brass Company. The test pieces were copper strips, cold-rolled to a temper approximately that of hard-drawn rectangular bus bar.
A. Electrolytic copper, silver content normal
B. Electrolytic copper, silver 8.7 ounces per ton added
C. Electrolytic copper, silver 28 ounces per ton added

In heavily loaded motors and generators, the windings, collector rings, and commutators must retain their strength at the higher operating temperatures that have become the rule. And there are now many other places where copper conductors must operate at temperatures well above those heretofore considered normal.

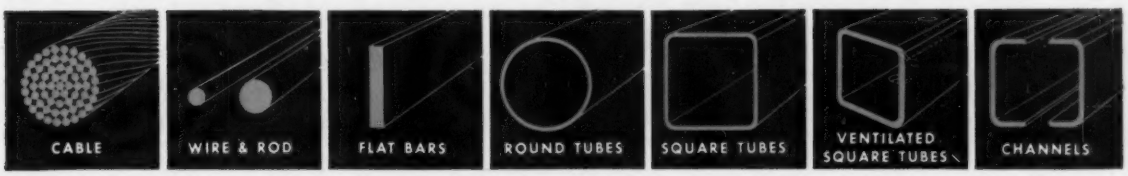
Electrolytic copper—with a very small amount of silver added—is superior to any other commercial conductor metal for use at these higher temperatures. Anaconda silver-bearing copper retains the structural design strength of the conductor at the higher operating temperatures. Annealing temperature is raised and softening delayed. The margin of safety is improved. How much gain you can count on is indicated by the chart above.

More complete information is available in the brand-new Fifth Edition of The American Brass Company's Publication C-25, "Anaconda Copper for Electrical Conductors." In addition, this 62-page booklet has convenient new tables giving physical and electrical data on all types of rigid bus conductors for the most commonly used sizes—plus a wealth of general information on the properties of copper conductors.

TECHNICAL SERVICE. The assistance of Anaconda specialists in the selection of conductors to meet your special problems is available to you. For such assistance — or to get a copy of "Anaconda Copper for Electrical Conductors" — see your nearby Anaconda representative. Or write: The American Brass Company, Waterbury 20, Conn. 56100

ANACONDA® COPPER CONDUCTORS

THERE'S AN ANACONDA ELECTRICAL CONDUCTOR FOR EVERY NEED



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Specify Panel Chanel—the laminated plastic wiring duct that will not distort under high control panel temperatures. It's moisture resistant, too, won't sag or warp out of shape. And Panel Chanel simplifies control panel layout, saves wiring time, eases wiring changes. Most complete variety of sizes and types to fit specific applications.

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Electrical Engineering Problems in the Rubber and Plastics Industries

Papers presented at the Third Annual Conference of the AIEE Subcommittee on Rubber and Plastics Industries on May 5, 1950, in Akron, Ohio and at the Fourth Annual Conference held on April 28, 1952 in Akron.

The program for the Third Conference consisted of a one-day meeting, with nine papers and eight prepared discussions. The program for the Fourth Conference also consisted of a one-day meeting with eight papers and two prepared comments. At both conferences there was extemporaneous discussion which is included in the publication.

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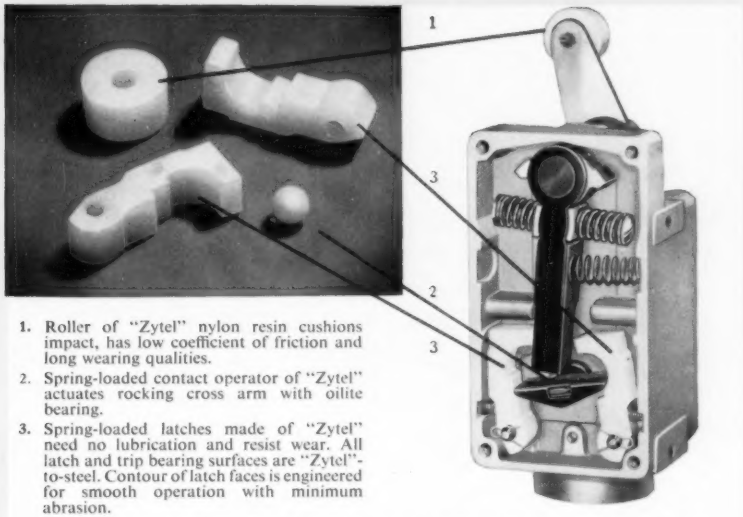

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3. Spring-loaded latches made of "Zytel" need no lubrication and resist wear. All latch and trip bearing surfaces are "Zytel"-to-steel. Contour of latch faces is engineered for smooth operation with minimum abrasion.

The roller and latches on this Clark limit switch are made by Polymid Plastic Products Company, Linwood, Michigan; the ball by Ace Plastic Company, Jamaica, N. Y.; the follower is machined from rod stock furnished under the trademark "Polypenco" by the Polymer Corporation, Reading, Pennsylvania.

The Clark Controller Company new machine limit switch is used to control mechanical operations in a variety of industries. The limit switch takes a mechanical impulse and transforms it into an electrical operation—breaking or transferring electrical connections in machinery.

Abrasion-resistant and long wearing parts of "Zytel" nylon resin give longer life to the Clark limit switch. Rollers, latches and actuators of Du Pont "Zytel" can take rugged treatment because they are strong and resilient. Parts of "Zytel" absorb the constant movement of the mechanism and yet give over twice the service life required.

"Zytel" can be economically injection molded or machined from shapes at a low unit-cost. Furthermore, maintenance costs are low with "Zytel" which requires no lubrication in this operation. For information on the possible use of "Zytel" nylon resin in your products mail the coupon on the reverse side.

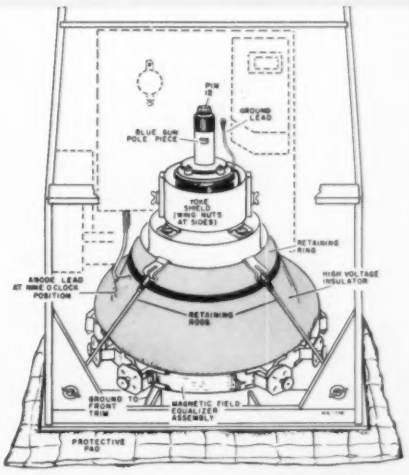
Shield of ALATHON® solves insulation problem in new RCA-Victor color TV receiver

"Alathon" has high dielectric strength, is strong and lightweight

The picture tube in the new RCA-Victor color television receiver operates at 25,000 volts. To provide insulation for this tube, RCA-Victor engineers needed a material that could be readily and inexpensively molded into the complex shape of a kinescope shield . . . yet had high dielectric strength. Du Pont "Alathon" polyethylene resin proved to be an ideal material for the shield on all counts. In addition to providing the needed insulation, the shield of "Alathon" gives mechanical protection to the tube when it is shipped or handled.

"Alathon" not only has excellent insulating properties but is strong, lightweight and flexible. It is chemical-resistant, as well as odorless, tasteless and non-toxic. Because of these properties, and the ease with which parts can be molded, extruded or fabricated, "Alathon" has been successfully employed as insulation and jacketing for wire, in storage batteries and many other electrical applications.

Kinescope shield molded by Sinko Manufacturing & Tool Co. Chicago, Illinois.



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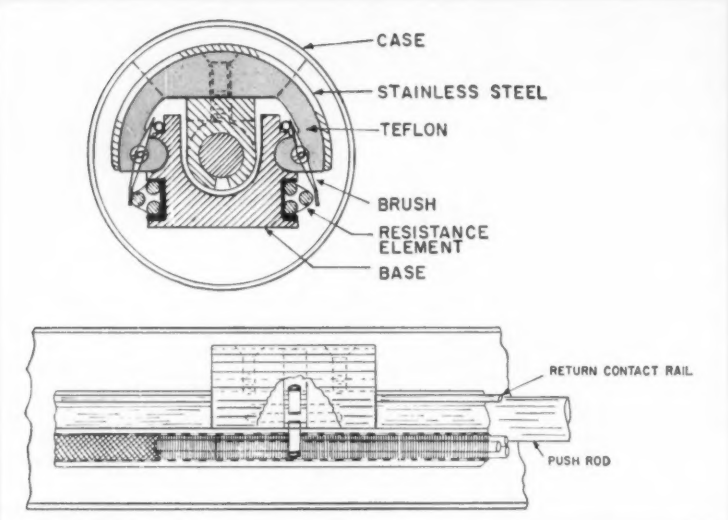
ELECTRICAL MANUFACTURING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

Heat resistance, low friction of TEFLON® answer design problem in miniaturization of potentiometers



Cross section of a typical dual rectilinear potentiometer with insulation of "Teflon." Du Pont "Teflon" protects the core from heat and friction.

Miniaturization in guided missiles and other airborne equipment has called for improvement in design and insulation of potentiometers. Du Pont "Teflon" tetrafluoroethylene resin has filled the insulation requirements. A trunnion pin fitted into two shoes of "Teflon" holds the double-leaf brush in the new line of high-temperature potentiometers manufactured by the Pacific Scientific Company of Los Angeles, California.

The importance of "Teflon" in this application stems from its high heat resistance and low coefficient of friction. In use, this potentiometer must operate at temperatures as high as 400°F., and intermittently to 550°F. "Teflon" insulates the potentiometer and protects the core. The movement of the sleeve calls for a material with low friction. "Teflon" solves this problem, too.

In miniaturization where design is important, "Teflon" is of great advantage. It can be easily and economically molded into complex shapes which require little or no after-finishing. Its high dielectric strength makes it ideal for a great many electrical applications.

Economically molded printing wheels of ZYTEL® withstand constant hammering

The use of "Zytel" nylon resin for the printing wheel of the Kleinschmidt Teleprinter demonstrates the high impact strength of this versatile engineering material. With each character it reproduces on the tape, this wheel receives a sharp blow from a hammer in the mechanism. "Zytel" withstands this constant impact and prints clearly for many years.

Since silent operation and portability are factors in these machines, the resilience and lightness in weight of "Zytel" are advantageous. These one-piece printing wheels can be economically injection-molded and need no after finishing. In addition, "Zytel" cuts maintenance costs since it has superior abrasion resistance and in this application requires no lubrication.

Parts molded by Becwar Manufacturing Corporation, Addison, Illinois for Kleinschmidt, Inc., Deerfield, Illinois.

Investigate Du Pont engineering materials in your product development programs

One of the family of these versatile engineering materials is often a key factor in product improvement or new product design.

The wide range of properties available with "Alathon"* polyethylene resin, "Lucite"* acrylic resin, "Teflon"* tetrafluoroethylene resin, and "Zytel"* nylon resin are helping solve industrial design problems.

NEED MORE INFORMATION?

Clip the coupon for additional data on the properties and applications of these Du Pont engineering materials.

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For more detailed information, send for Burndy Bulletin MAG 55. For recommended die sets and terminals, write:

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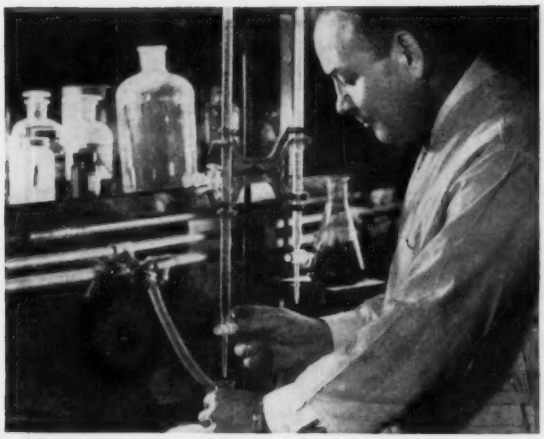
The *quality* of raw materials used in the manufacture of porcelain suspension insulators has a direct bearing on insulator performance.

Only a slight variation from standards in the chemical composition of clay, in the vitrifying characteristics of feldspar, or in the purity of flint can result in loss of insulator strength.

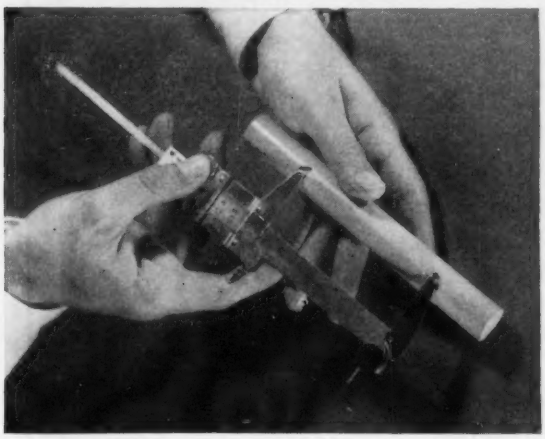
To protect you against the possibility of insulators made of inferior raw materials, Locke subjects flint, feldspar and clay to 14 different quality control tests... *before shipments even enter our plant.* This prevents trouble before it starts!

The case of Locke Raw Material "Quality Control" is typical of the extremes to which Locke goes to assure trouble-free insulator service on your system.



DROP BY DROP, an analyst determines the exact proportions of silica and oxides of aluminum, sodium, potassium as well as other elements in clays and feldspar. Results are used as a production guide to assure uniformity.

FINENESS OF FLINT and feldspars is accurately determined by a screen test and compared with standards before a shipment is accepted. This physical property has direct effects on firing characteristics of these materials.



AS CLAY SHRINKS by about one eighth between forming and firing, shrinkage properties must be known in advance, so that insulator size can be accurately maintained. Test bars are extruded, notched and measured before and after drying, as well as after firing.

CLAY SAMPLE, mixed by two augers in a temperature-controlled hopper predicts how material will behave in the plastic state. The applied torque required to deform the clay sample is indicated on a chart.

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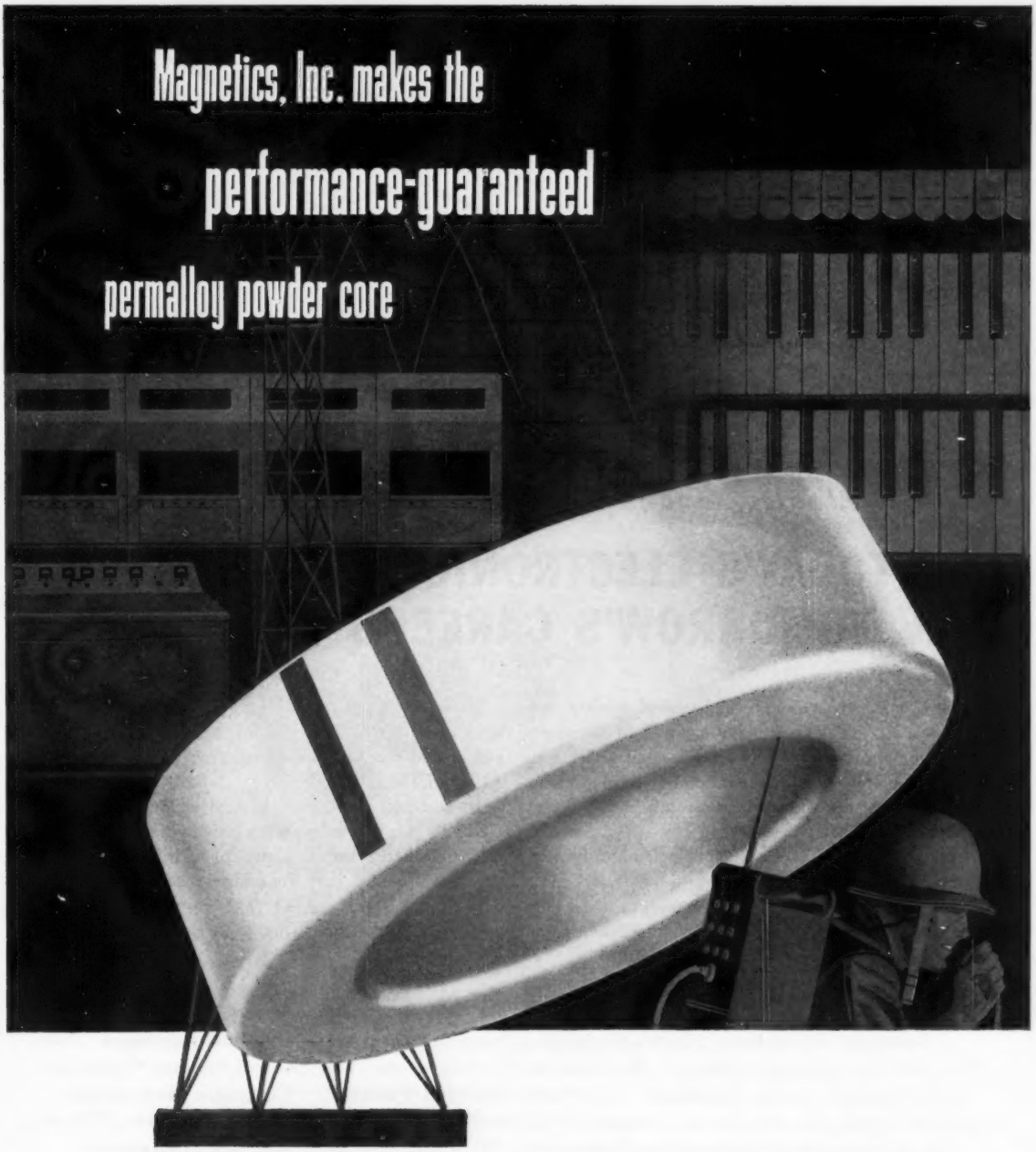

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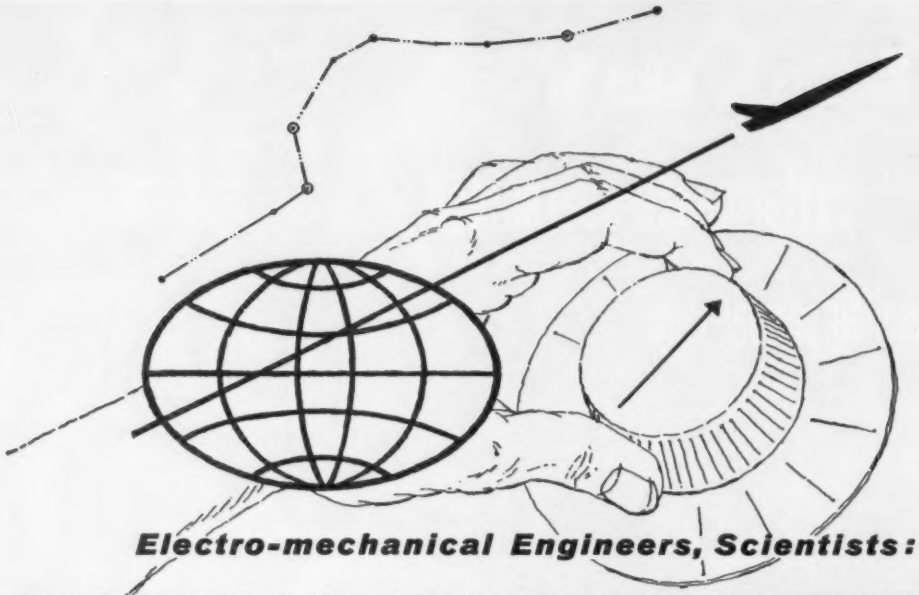

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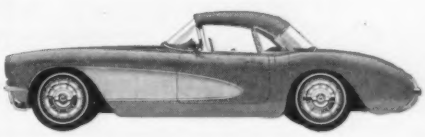

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Photo, above: Engineering writer working with Hughes engineers on a design phase of the Hughes Falcon air-to-air guided missile.

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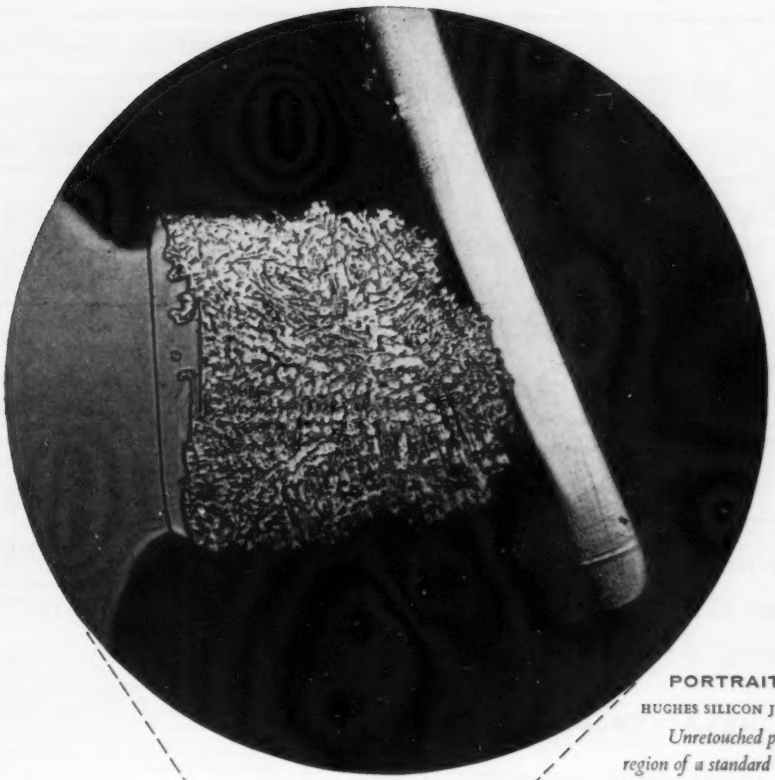

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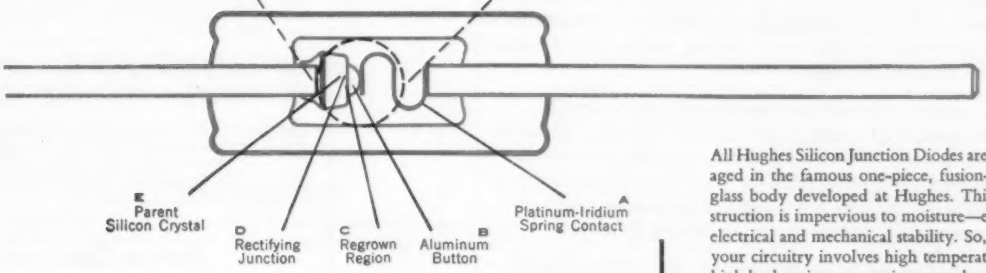

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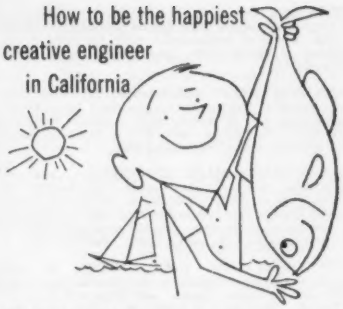

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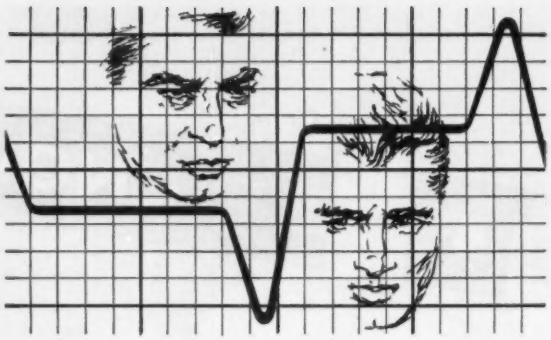

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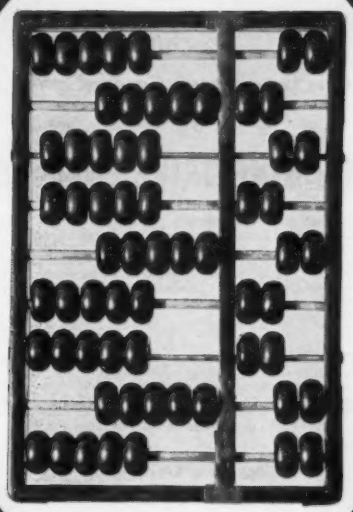

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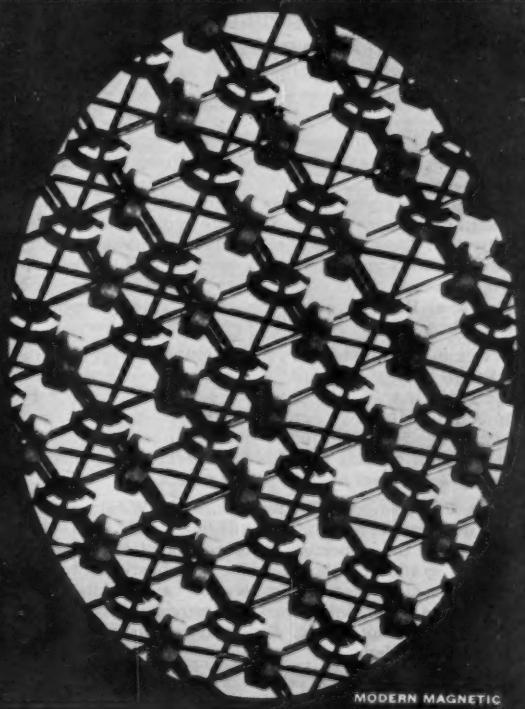

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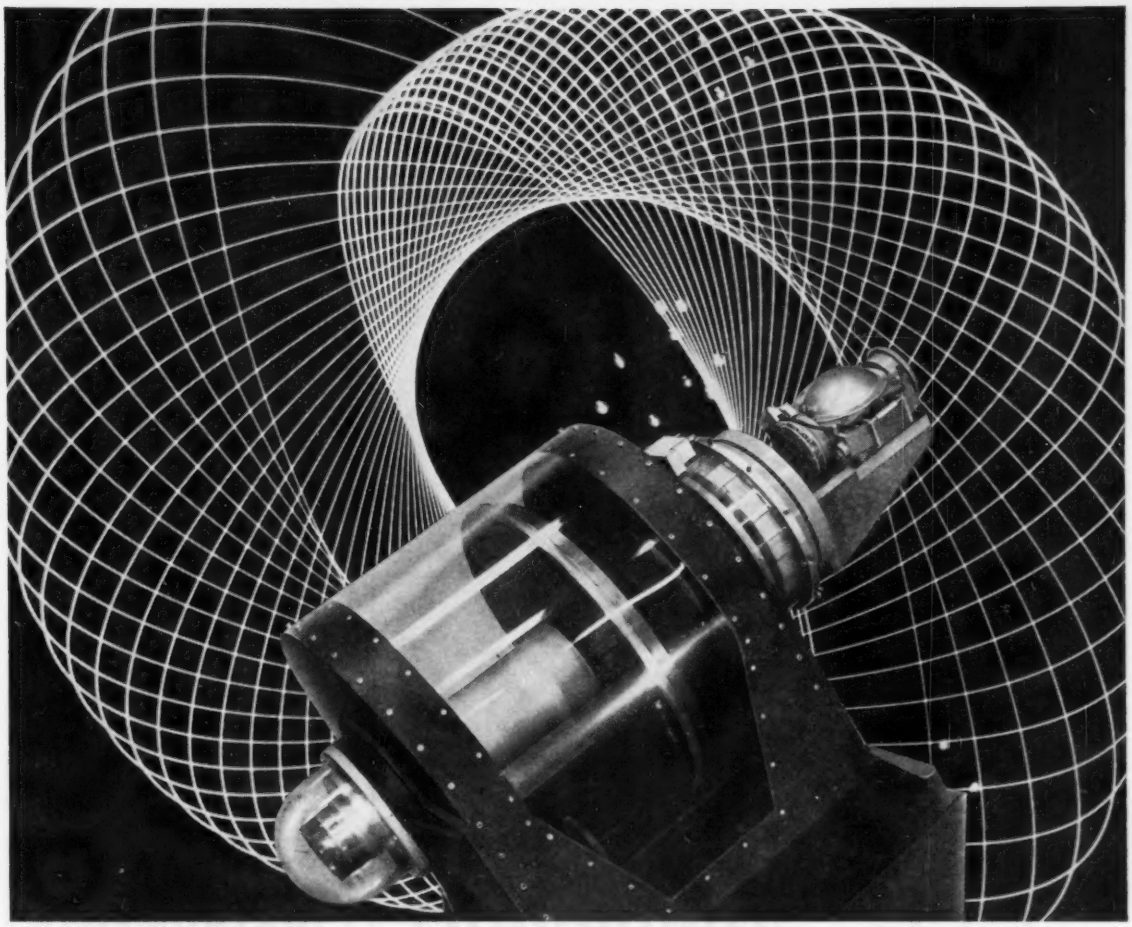

$$\bar{r}(t) = \int_0^t (t - \tau) \left[\frac{d^2\bar{r}}{d\tau^2} - \bar{\omega} \times (\bar{\omega} \times \bar{r}) - \frac{d_r\bar{\omega}}{d\tau} \times \bar{r} - 2\bar{\omega} \times \frac{d_r\bar{r}}{d\tau} \right] d\tau$$

$$\bar{L} = \frac{d_r}{dt} (\bar{\bar{I}} \cdot \bar{\omega}) + \bar{\omega} \times (\bar{\bar{I}} \cdot \bar{\omega})$$

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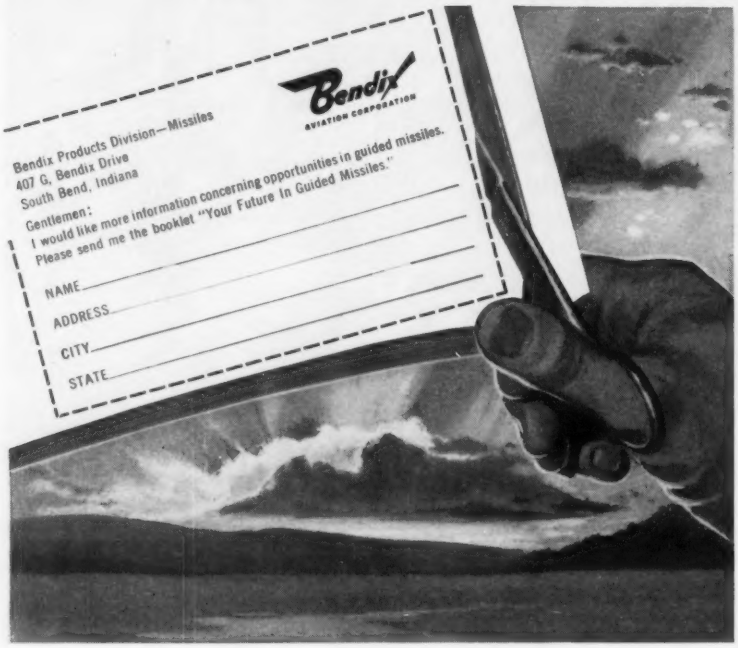

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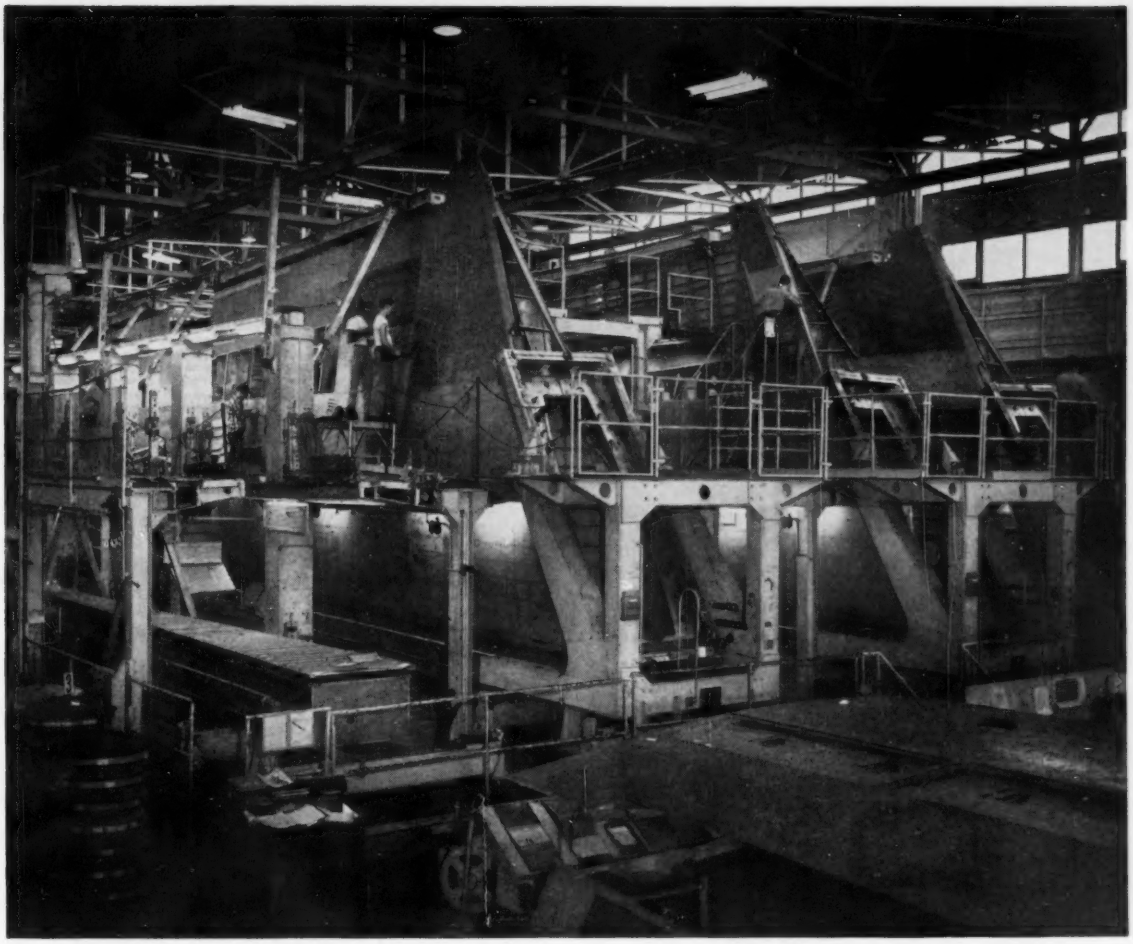

Boeing production engineering—precision on a big scale

This Boeing B-52 wing jig is 90 feet long and weighs more than 1,000 tons. Yet many of its tolerances are within 1/1000 of an inch—as close as a fine watch! Electrical engineers, who were responsible for calculating the wiring and electrical loads on it, face some of the most stimulating challenges in production today.

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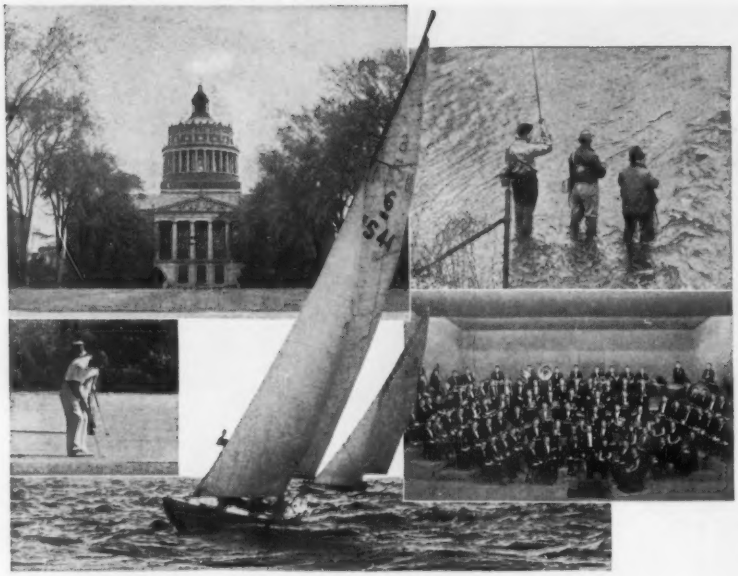

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ELEC ENGR, M.S.E.E., 36, married, 2 children; directed factory elec motors and other elec items. Projected and supvd important theatrical and lighting installations, etc. Patents, publications, lectures in field. Spanish, French, Italian, Portuguese. Will locate anywhere in U.S. Available for interviews. E-851.

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RESEARCH ENGINEER, graduate electrical, preferably in high-voltage engineering; sound mathematical background, to supervise research and development work in electrical laboratory of a small electrical manufacturing company specializing in electro-mechanical audio-frequency responsive devices, and in the measurements of a-c and d-c characteristics of dielectrics. Location, Pennsylvania. W-2804.

TEACHING PERSONNEL for the electrical engineering department. Degree and experience will determine rank and salary. Location, South. W-2825.

TECHNICAL EDITOR, electrical graduate, with at least five years' specification, technical writing and editing experience in industrial electronic control fields. Salary, $7000 a year. Location, New York, N. Y. W-2833.

ENGINEERS. (a) Chief Engineer, electrical or mechanical graduate, with at least ten years' chief project engineering experience in electronic component manufacturing. Salary, $12,000 a year. (c) Electronic Engineer with design and development experience on communication equipment including d-c circuits. Salary, $6000–$8000 a year. Location, New England. W-2861.

ELECTRICAL ENGINEERS. (a) Junior Engineer, recent graduate, to assist experienced engineers. This is a training position for recent graduates not to exceed two years after graduation. (b) Assistant Engineer, mechanical or electrical, to work under the guidance of experienced engineers with responsibilities for performance of specific work assignments on small electro-

mechanical devices. (c) Engineer with creative engineering ability and a knowledge of manufacturing systems and processes for small electro-mechanical devices. (d) Senior Engineer responsible for design of apparatus which involves creative ability of highest order. Salaries: (a) $3804–$5564; (b) $4680–$6900; (c) $6240–$8700; (d) $8040–$11,100 a year. Location, Connecticut. W-2882.

ENGINEERS. (a) Instrument Engineer, 25–40, B.S. in electrical or chemical engineering; minimum of three years' industrial experience in the application of all types of pneumatic instruments to chemical process control. Location, Louisiana. (b) Senior Electrical Engineer, 28–45, graduate, with five years' design experience with industrial control equipment, regulating systems, mill controls and processing equipment, etc. Will prepare electrical specifications for new equipment to be purchased. Work out improved electrical controls on existing equipment; make estimates on all kinds of electrical installations; direct work of junior engineers. Salaries open. Location, West Coast. W-2911.

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ELECTRICAL ENGINEERS, Senior, Assistant and Junior, graduates, for electrical design, distribution and transmission systems for public utility power plants. Salary open. Location, New York, N. Y. W-2918.

RESEARCH ENGINEER for contract research and/or teaching, with three to four years' experience on electrical research and unconventional power supplies. Will be allowed to take six credits toward advanced degree. Salary, $6000 a year. Location, Midwest. W-2923.

DESIGN ENGINEERS, graduate electrical, mechanical and structural, for work on heavy building construction foundations, installation of equipment and substations and distribution. Salary open. Location, Connecticut. W-2938.

SALES ENGINEER, graduate electrical, to sell DC power supplies and AC line regulators for electronic and electrical industry. Should have previous sales experience in New York area. Salary plus commission, plus expenses. Must have car. Territories, New York, N. Y. and possibly upstate New York. W-2949.

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PLANT ENGINEER, electrical or mechanical, with a minimum of five years' experience in plant layout, installation of machinery, etc. Company constructs new plants. Must have heavy design experience. Salary, $8000–$8500 a year. Location, northern New Jersey. W-2957.

ENGINEERS. (a) Electronic Design Engineer to design electronic instruments, involving the measurement of temperature, pressure, liquid level and flow. (b) Atomic Energy Engineer with some experience in process control systems analysis, instrument design and application of either industrial or atomic energy commission instruments involving mechanical, chemical, electrical or electronic instruments and controls. Location, upstate New York. W-2959.

PLANT ENGINEER, young, no previous experience necessary; electrical graduate, to work as assistant in chemical and metallurgical manufacturing company. Salary, $5200 a year. Location, eastern Pennsylvania. W-2964.

ASSISTANT MANAGER OF PURCHASING, 40–45, college graduate, with at least 15 years' heavy industry experience and at least four years' top administrative responsibility for purchasing functions over multi-plant heavy industry. Experience in steel, heavy chemicals, or aluminum industry desirable. Should be member of National Association of Purchasing Agents. Salary open. Location, West Coast. W-2966.

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ENGINEERS. (a) Assistant to Sales Manager, 32–40, preferably graduate electrical with an MBA, to assist in formulation of sales policies and practices, etc. Must have had actual field sales experience in industrial capital goods. Salary, $7200–$12,000 a year, plus bonus. (b) Sales Manager, Paper Industry, 30–45, graduate electrical or mechanical, MBA desired, with full knowl-

(Continued on page 110A)

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(Continued from page 109A)

edge of paper processes. Must have sales experience in capital equipment to the paper industry. Will be responsible for success of company's operations on the paper industry. (c) Executive Assistant to the President, 35–38, preferably graduate electrical engineer and a business school graduate, with industrial capital equipment sales and sales management experience. Will assist president of corporation on long term and short range planning, organization, procedures, policies, etc. Must be willing to travel. Salary, $9000–$15,000 a year plus bonus. Location, Ohio. W-3000.

ENGINEERS. (a) Project Manager, graduate electrical, with a minimum of 15 years' design experience and a high degree of technical knowledge, administrative ability, capable of handling group, managing budget, etc. Must be completely familiar with several process industries such as food processing, textile, paper, rubber, steel, tobacco manufacture. Will be responsible for engineering group performing design and development of measurement and control system for process industries. Salary, $10,000 a year and up depending upon capabilities, plus bonus. (b) Development Engineer, electrical graduate, with one to fifteen years' electronic design experience; experience in system design desirable. Will do design and development work on electronic industrial measurement and control equipment. Salary, $4800–$8400 a year. (d) Nuclear or Radiation Physicist for research and development work involving beta, gamma or neutron source design, including collimation, filtering and shielding; design of detection units, including ionization chambers, geiger tubes and scintillation crystals; beta and gamma ray spectrometry. Salary, $6000–$7800 a year plus bonus. Location, Ohio. W-3001.

SALES MANAGER, graduate electrical preferred, to supervise sale and distribution of mica, varnish cambric insulation and other types of insulated materials. Must have had actual sales experience with these products. Salary, about $5000–$6000 a year to start. Location, New England. W-3006.

TEACHING PERSONNEL, rank depending on qualifications. (a) One for electronics field with good background in advanced mathematics and analysis. Ph.D. desired. Some experience in industry and education. (b) One thoroughly grounded in fundamentals to teach beginning courses in electrical engineering and possibly one advanced course. Master's degree desirable. (c) One to teach non-electrical engineers, primarily courses offered to mechanical and civil engineers. Master's degree desired and some experience in industry and teaching. Salaries open. Location, New England. W-3009.

TEACHING PERSONNEL. (a) Professor, Ph.D. in electrical engineering, for teaching and research in electro-magnetic theory and antenna work. Salary, $8000–$12,000 a year. (b) Instructor to teach electrical engineering, starting September 1956. Salary, $4800-$6000 a year. (c) Research Personnel to do research and development work in the field of communication. May take graduate work. Location, South. W-3015.

ELECTRONIC SYSTEMS ANALYST, B.S. in physics with electrical engineering minor or B.S. in E.E. with electronics major; with one to two years' experience in digital electronic installations. Will be primarily responsible for the evaluation and coordination of electronic equipment. Salary, to $9000 a year. Location, New Jersey. W-3018.

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ASSISTANT PROFESSOR, M.S. or Ph.D. is preferred, or a B.S. considered provided applicant has teaching or equivalent experience. Will teach general electrical engineering subjects in the power field. Salary, $5500-$6000 a year. Location, Southwest. W-3029.

ASSISTANT SALES MANAGER, electrical graduate, to 38, with at least three years' experience in sales of electronic equipment. Will assist sales manager in developing sales of electronic equipment. Salary, $7500–$10,000 a year. Location, northwest Chicago suburb. C-4550.

CHIEF ENGINEER, graduate electrical, about 30, with at least five years in design and development of dry and liquid transformers. Will be chief engineer in charge of all development and design of heavy power transformers up to 5000 kva. Present engineering department consists of 6 people. Salary, $8000–$12,000 a year depending upon experience. Employer will pay placement fee. Location. Chicago, Illinois. C-4649.

METHODS AND PRODUCTION ENGINEER, 25–35, with at least three years' experience in production engineering including methods and processing. Knowledge of small electrical assembly. Will do production work, plant layout, methods, rates, tooling and material handling. Company is manufacturer of electrical parts. Salary, $7200 a year. Employer will negotiate fee. Location, Chicago, Illinois. C-4681.

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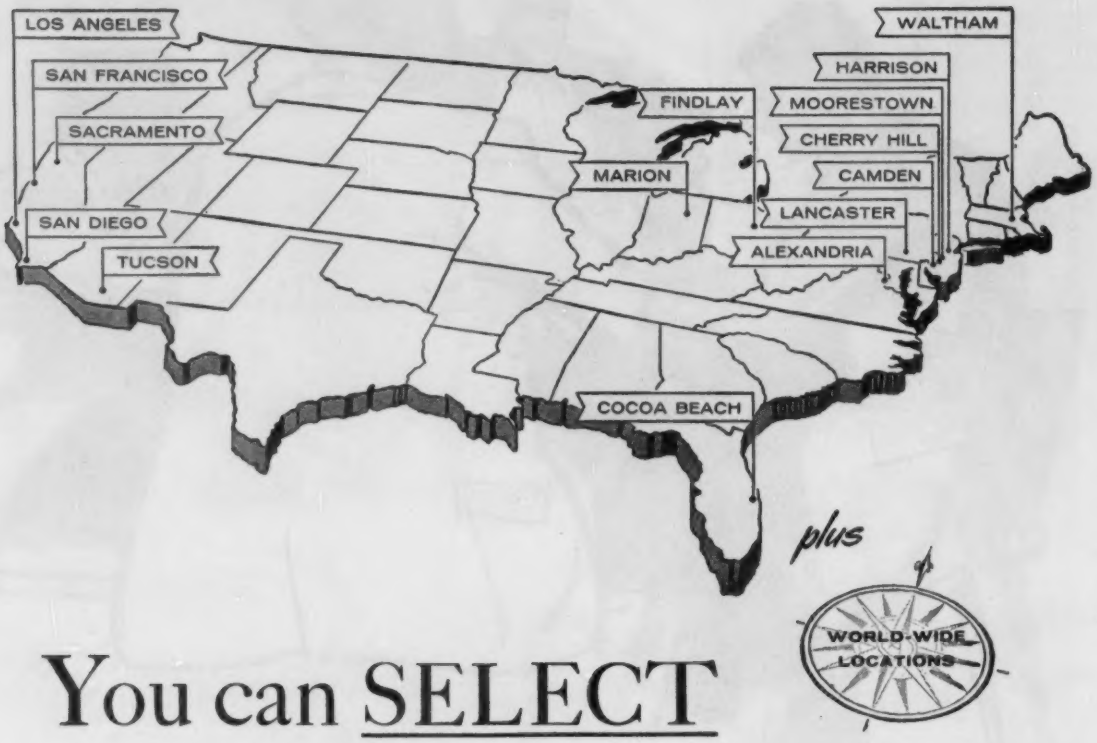

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...Here are the Opportunities!
...Here are the Locations!

FIELDS OF ENGINEERING ACTIVITY		MANAGERS	TYPE OF DEGREE AND YEARS OF EXPERIENCE PREFERRED											
			Electrical Engineers			Mechanical Engineers			Physical Science			Chemistry Ceramics Glass Technology Metallurgy		
			0-2	2-3	4-15	0-2	2-3	4-15	1-2	2-3	4-15	1-2	2-3	4-15
• ***SYSTEMS*** *(Integration of theory, equipments and environment to create and optimize major electronic concepts.)*	**AVIATION ELECTRONICS • CONTROLS**			W	W M			M		W	W M			
	DIGITAL DATA HANDLING DEVICES	M C		M C	M C		C	C		C	C			
	MISSILE ELECTRONICS • RADAR	M W		M W X	M W X		M W	M W		M W	M W			
	INERTIAL NAVIGATION	W			W			W			W			
	COMMUNICATIONS				C						C			
• ***DESIGN • DEVELOPMENT*** **KINESCOPES (B & W and COLOR), OSCILLOSCOPES**—Electron Optics—Instrumental Analysis—Solid States (Phosphors, High Temperature Phenomena, Photosensitive Materials and Glass to Metal Sealing)			L	L Y	L Y	L	L Y	L Y	L	L	L	L	L Y	L Y
RECEIVING TUBES—Tube Design—Test and Application Engineering—Chemical and Physical Development—Methods and Process Engineering—Advanced Development			H	H	H		H	H		H	H		H	H
SEMI-CONDUCTORS—Transistors—Semi-Conductor Devices—Materials			H	H	H	H	H	H	H	H	H	H	H	H
MICROWAVE TUBES—Tube Development and Manufacture (Traveling Wave—Backward Wave—Magnetron)		H		H	H		H	H		H	H		H	H
GAS, POWER AND PHOTO TUBES—Photosensitive Devices—Glass to Metal Sealing—UHF and VHF—Power			L	L	L	L	L	L	L	L	L	L	L	
AVIATION ELECTRONICS—Radar—Computers—Servo Mechanisms—Shock and Vibration—Circuitry—Remote Control—Heat Transfer—Sub-Miniaturization—Automatic Flight—Automation—Transistorization		W C	W C X	W C X	W C X	W C	W C X	W C X	W C X	W C X	W C X			
COMPUTERS—Systems—Advanced Development—Circuitry—Assembly Design—Mechanisms—Programming			C	C X	M C X	C	C X	M C X	C	C	M C			
RADAR—Circuitry—Antenna Design—Servo Systems—Gear Trains—Intricate Mechanisms—Fire Control—Information Handling—Displays		M C	M C X	M C X	M C X	M C X	M C X	M C X	M C X	M C X	M C X			
COMMUNICATIONS—Specialized Military Systems—Microwave—Aviation—Audio—Propagation Studies			C	C	C		C	C	C	C	C			
MISSILE ELECTRONICS—Systems Planning and Design—Radar—Fire Control—Shock Problems—Servo Mechanisms		M	M X	M X	M X	M	M	M X	M	M X	M X			
COMPONENTS—Transformers—Coils—TV Deflection Yokes (Color or Monochrome)—Resistors—Ferrites (Material and Parts)			C	Z C	Z C	C	Z C	Z C	C	C	C		Z C	Z C
• ***SYSTEMS APPLICATION*** *(Evaluation and Planning—Design and Development—Modification—Specification)*														
MISSILE TEST INSTRUMENTATION (Data Acquisition and Processing)—Radar—Telemetry—Timing—Communications—Optics—Computers		F	F S	F S	F S	F S	F S	F S	F S	F S	F S			
RADAR—Airborne—Surface—Shipboard—Sonar—Fire Control		F	F S	F S	F S	F S	F S	F S	F S	F S	F S			
COMMUNICATIONS—Radio—HF—VHF—UHF—Microwave—Telephone—Teletype—Telegraph Terminal Equipment—Wave Propagation		F	F S I	F S I	F S I	F S	F S	F S	F S	F S	F S			
• ***MACHINE DESIGN*** **Mechanical and Electrical—Automatic or Semi-Automatic Machines**			L	L		L	L H Y	C H Y		L	L			

Locations: C—Camden, N.J. **F**—Cocoa Beach, Fla. **H**—Harrison, N.J. **I**—International Div. **L**—Lancaster, Pa. **M**—Moorestown, N.J. **S**—RCA Service Co. (Cherry Hill, N.J.; Alexandria, Va.; Tucson, Ariz.; San Diego, Sacramento, San Francisco, Calif.; Foreign Assignments). **W**—Waltham, Mass. **X**—Los Angeles, Calif. **Y**—Marion, Ind. **Z**—Findlay, Ohio

Please send resume of education and experience, with location preferred, to:

Mr. John R. Weld, Employment Manager
Dept. A-14D, Radio Corporation of America
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This unit was built for use in connection with high voltage electrostatic separation and collection of various types of atmospheric particles.

Designing a Dry Type transformer in this voltage class that provides safe and efficient performance, is another notable example of Acme Electric transformer engineering.

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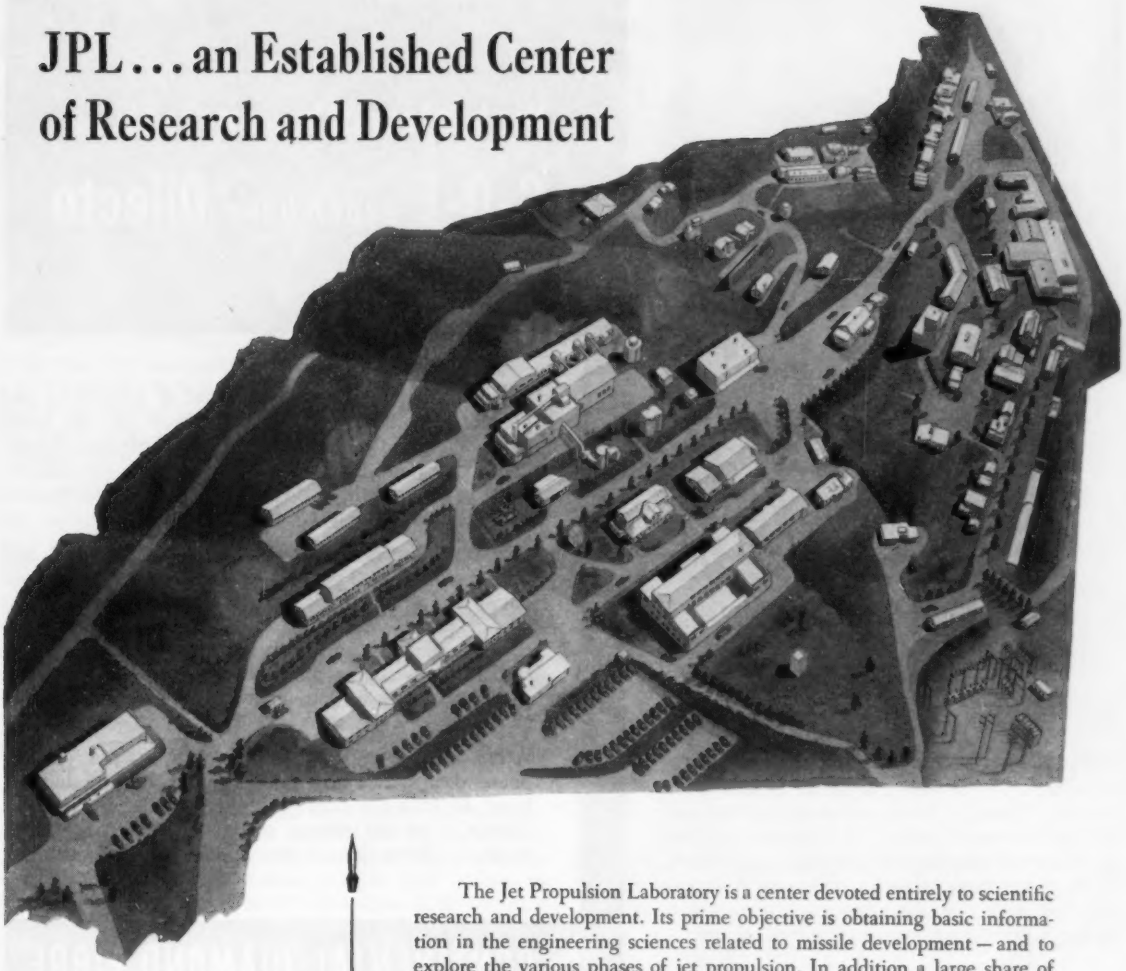

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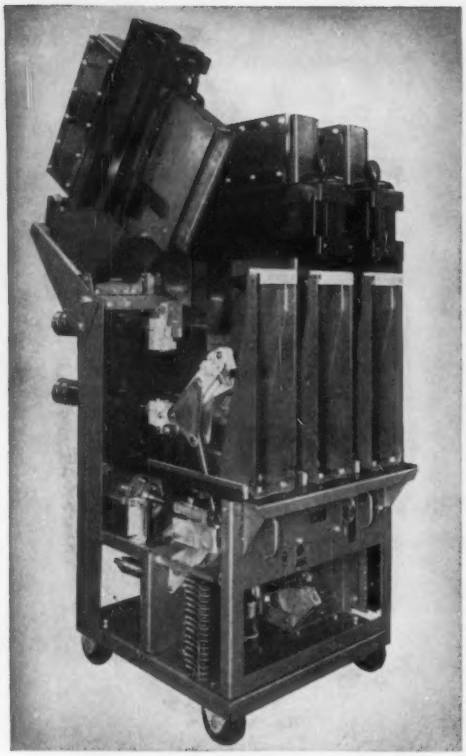

ROLLED AND MOLDED ARC CHUTE SHELLS, made by C-D-F for the I-T-E Circuit Breaker Company for 7.5 and 15 KV air magnetic circuit breaker, are good examples of paper-base Dilecto doing a hard job. Each completely closed insulating shell (NEMA grade X) has flame-retardant construction, negligible water absorption, and high dielectric strength at all points to withstand impulse test requirements.

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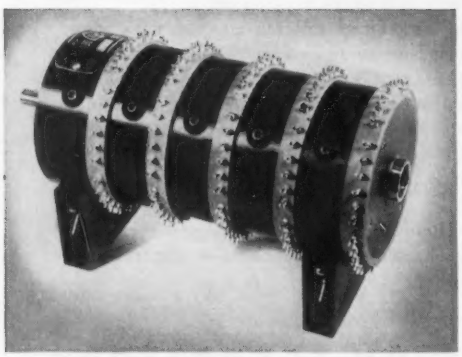
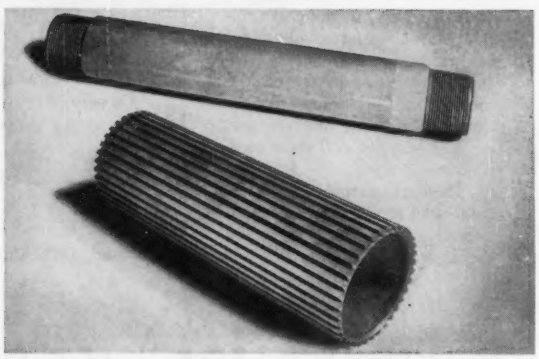


THIS HIGH-SPEED SAMPLING SWITCH, for missile telemetering and automation applications has a paper-base Dilecto tubing body. Materials engineers at General Devices, Inc., selected Dilecto "for its mechanical properties and low moisture absorption."

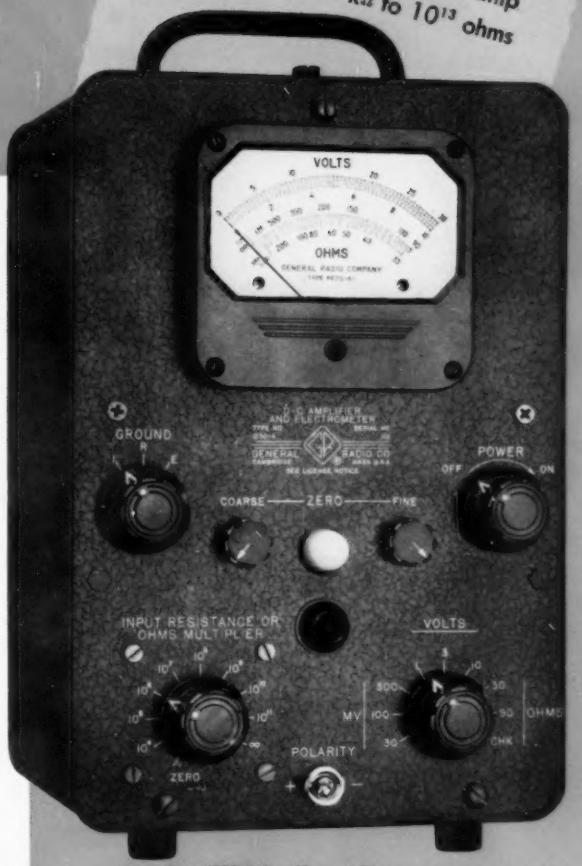


ACCURATE MACHINING, SMOOTH FINISHING are two merits of paper-base Dilecto. Note the perfection of milling cuts and threads! C-D-F has mass-production equipment, or can furnish sheets, tubes and rods with cost-cutting machining information.

All in One Package!

Millivoltmeter
Micro-microammeter
Mega-megohmmeter

Ranges, Full Scale
Voltage: 30 mv to 10 volts
Current: 1 ma to 3 x 10^{-13} amp
Resistance: 300 kΩ to 10^{13} ohms



Type 1230-A Amplifier and Electrometer as shown, $440.
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The G-R Type 1230-A D-C Amplifier and Electrometer represents a new and important contribution to the field of electrical-measuring equipment.

A *low-cost* instrument of high performance for the measurement of extremely small d-c voltages, currents and charges has not been hitherto available. As if not enough, this device is also a completely self-contained megohmmeter with provision for measuring higher resistances than possible with many instruments specializing in this measurement. Output jacks, at the rear, permit use as a sensitive d-c amplifier to drive 1-ma or 5-ma recording equipment such as the Esterline Angus Recorders.

Superior performance is obtained through a carefully thought-out design. An electrometer tube is used in the first of three direct-coupled stages to keep grid current effects truly negligible. The stringent stability requirements necessary for an instrument such as this are met through use of excellent supply regulation, insulation of the highest quality, shock mounting, wire-wound resistors at all critical locations, and aging of both tubes and components . . . in short, through adherence to the high standards of engineering and manufacture which have come to be expected of the General Radio Company.

The Type 1230-A Amplifier and Electrometer has many applications in industrial-process control and in physical and chemical research, in addition to its obvious uses in the electronics laboratory. The instrument may be used: to operate from strain gauges; to indicate or record time-current curves of capacitors under charge or discharge; to record life tests on vacuum tubes and other components; to measure semi-conductor resistance, piezo-electric potentials, electrostatic fields, ph indications, contact potentials, grid currents in tubes, and insulation resistance of motors, generators and appliances; and, in general, to measure any physical or chemical reaction where a d-c voltage or current proportional to the change is available.

This instrument is a truly versatile device . . . one we're proud to present, and one every laboratory will want to own.

Six Voltage Ranges: ±30 mv, 100 mv, 300 mv, 1v, 3v, and 10v d-c, full scale — accuracy, 2% of full scale on all five higher ranges, 4% of full scale on lowest 30-mv range.

Twenty Current Ranges: from ±1 ma to ±3 x 10^{-13} amp d-c, full scale — accuracy, 3% of full scale from ±1 ma to ±3 x 10^{-9} amp and 10% to ±3 x 10^{-13} amp.

Sixteen Resistance Ranges: direct reading 300 kΩ to 10 MMΩ, full scale; 5 x 10^{14}Ω at smallest meter division — accuracy, 3% from 3 x 10^{5}Ω to 10^{13}Ω and 8% to 10^{13}Ω — with external 300v batteries in place of the internal 9v source, resistance range can be extended to read 6 x 10^{16}Ω at smallest meter division.

Since resistance is easily measured with different voltages applied to the unit under test, voltage coefficients are readily obtained.

Internal Resistance Standards: 10^{4} and 10^{5} ohm steps accurate to 0.25%; 10^{6}, 10^{7} and 10^{8} ohms accurate to 1%; 10^{9}, 10^{10}, 10^{11} ohms accurate to 5% and have been treated to prevent adverse humidity effects. 0 and ∞ steps also available.

Switch provided for checking higher resistance standards in terms of more precise 10^{4} and 10^{5} ohm wire-wound units (makes possible working back to high basic accuracy over the complete range).

High Input Resistance: determined by setting of resistance standards switch; 10^{14} ohms at "open" position; input insulation is entirely teflon and siliconized glass, insuring reliable operation under high humidity conditions.

Drift: less than 2 mv per hour after initial warm up.

Temperature, Humidity, Line-Voltage Effects: all negligible.

Output: panel meter indicates voltage, current and resistance; output jack provided for connecting recorder having resistance up to 1500Ω.

Guard Terminals: three terminals in addition to input and output provide versatility in ground and guard connections.

Input Switch Disconnects Unknown: without upsetting unknown or electrometer input circuit.

Power Supply: 105-125v (210-250v), 50-60 cycles.

Useful Accessories:
Esterline Angus 5-ma or 1-ma Graphic Recorder.

G-R Type 1230-P$_1$ Component Shield at $40 provides a fully shielded chamber for measurement of very high resistance components.

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...with RCA super-power tubes

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Using concepts unusual in vacuum-tube design—including unique principles of electron optics, interelectrode shielding, and tube geometry—RCA Super-Power Tubes begin their work where conventional power tubes leave off.

Ingenious internal liquid cooling of tube electrodes and unitized coaxial design make it practicable to generate higher power at much higher frequencies. Thoriated-tungsten or matrix-type cathodes provide exceptionally high emission, economical power consumption, and long life. Efficiency of rf transfer is assured through the use of high-conductivity seals and low-loss ceramic bushings.

Mechanical configurations—heretofore considered impossible—provide a new twist to vacuum-tube design to accomplish super-power generation. The ability of these tubes to handle high average power in cw operation permits unusually high power outputs in pulse and hard-tube modulator operation. All tubes are designed for single or multiple operation—for new work where higher and higher power extends the use of electronics.

RCA is ready to discuss with equipment manufacturers their present and future needs for Super-Power Tubes. Information may be obtained from the nearest RCA District Office—or write RCA, Section D16R, Commercial Engineering, Harrison, N. J.

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